SYNERGY®
MICROWAVE CORPORATION

Voltage Controlled Oscillators
Frequency Synthesizers
Mixers
Demodulators & Modulators
Power Dividers
Phase Comparators
Phase Detectors
Phase Shifters
Hybrids
Couplers
Frequency Doublers
Fixed Attenuators
Transformers
Filters
DC Block
Monolithic Amplifiers
Attenuators / Switches
Test Fixtures

Designer's Handbook

SYNERGY®
MICROWAVE CORPORATION

SYNERGY MICROWAVE CORPORATION *is an innovative leader in the design and manufacture of RF and microwave signal processing components. All of our products utilize state of the art design and manufacturing technology as we strive for customer satisfaction and engineering excellence.*

Our "Standard Parts Catalog" *includes the answer to virtually all of your signal processing needs, including double balanced mixers, image reject mixers, quadrature I.F. mixers, power dividers, couplers (directional and bi-directional), modulators (single sideband, bi-phase and quadra-phase), filters (low pass, bandpass and high pass), frequency doublers, phase shifters, phase detectors, attenuators, transformers and more. If you don't see it, just ask.*

We, here at Synergy, take pride in our consistent high quality, the best price/ performance ratio possible, responsive sales and applications assistance, and an answer to every question.

Synergy Microwave *... we're not just a components source, we're your partner.*

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QUALITY ASSURANCE

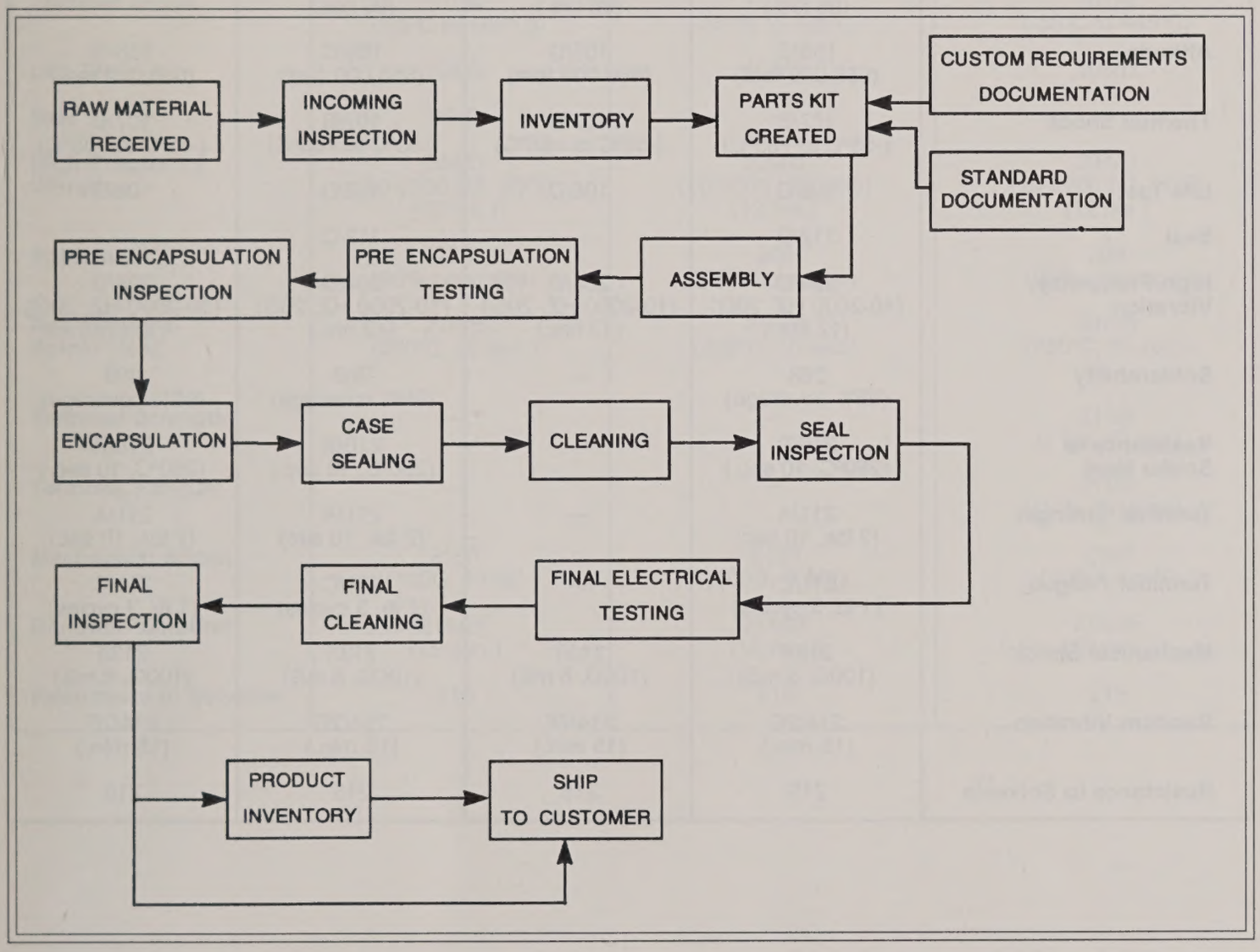
Synergy's Quality Assurance Program is governed by an inhouse Quality Assurance Manual which is structured around MIL-Q-9858 (Quality Program Requirements) and, as such, encompasses the requirements of MIL-1-45208 (Inspection System Requirements), and ISO9000. It is regularly maintained and updated.

The calibration of test equipment is controlled by Quality Assurance and is in conformance with MIL-STD-45662 (Calibration of Test Equipment), and is traceable to the National Bureau of Standards.

Synergy's workmanship standards are governed by "Synergy Microwave Workmanship Standards" manual, which encompasses the requirements of MIL-STD-454 (Standard General Requirements for Electronic Equipment). Synergy is also capable of workmanship standards in accordance with DOD-STD-2000 (high quality/high reliability soldering technology). Our products are assembled by trained personnel under strict supervision and inspection methods to insure quality and reliability. In addition, all devices (100%) are tested and final inspected prior to shipment.

Synergy Microwave knows that quality incorporates dedicated people working together within a quality controlled environment to design, manufacture, test, and inspect each device produced.

Below is how Synergy achieves such high standards.



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SYNERGY® MICROWAVE CORPORATION

ENVIRONMENTAL SPECIFICATIONS

Synergy's RF signal processing components are manufactured under a stringent quality assurance program and are designed to meet their published specifications, unless otherwise noted, over the operating temperature range of -55°C to +100°C and after exposure to the applicable environmental tests of MIL-STD-202F.

The environmental capabilities of Synergy's products are mainly determined by the package type utilized in construction of the device. The following are the package classifications and the applicable MIL-STD-202 specifications that apply:

Exposure Test	Metal Plug-In (Through-Hole)	Connectorized	Metal Flatpack	Plastic Flatpack
	Method/Test Condition	Method/Test Condition	Method/Test Condition	Method/Test Condition
Salt Spray (Corrosion)	---	---	---	---
Humidity	103 (90-95% RH, 40°C) (96 hrs.)	103 (90-95% RH, 40°C) (96 hrs.)	103 (90-95% RH, 40°C) (96 hrs.)	---
Altitude	105/G (656,000 feet)	105/G (656,000 feet)	105/G (656,000 feet)	105/G (656,000 feet)
Thermal Shock	107/B (-55°C to +85°C)	107/B (-55°C to +85°C)	107/B (-55°C to +85°C)	107/B (-55°C to +85°C)
Life Test	108/D	108/D	108/D	108/D
Seal	112/D	---	112/D	---
High Frequency Vibration	204/D (10-2000 HZ, 20G) (12 hrs.)	204/D (10-2000 HZ, 20G) (12 hrs.)	204/D (10-2000 HZ, 20G) (12 hrs.)	204/D (10-2000 HZ, 20G) (12 hrs.)
Solderability	208 (95% coverage)	---	208 (95% coverage)	208 (95% coverage)
Resistance to Solder Heat	210/B (260°C, 10 sec.)	---	210/B (260°C, 10 sec.)	210/B (260°C, 10 sec.)
Terminal Strength	211/A (2 lbs, 10 sec)	---	211/A (2 lbs, 10 sec)	211/A (2 lbs, 10 sec)
Terminal Fatigue	211/C (1 lb, 3 cycles)	---	211/C (1 lb, 3 cycles)	211/C (1 lb, 3 cycles)
Mechanical Shock	213/I (100G, 6 mS)	213/I (100G, 6 mS)	213/I (100G, 6 mS)	213/I (100G, 6 mS)
Random Vibration	214/2F (15 min.)	214/2F (15 min.)	214/2F (15 min.)	214/2F (15 min.)
Resistance to Solvents	215	215	215	215

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ENVIRONMENTAL SPECIFICATIONS FOR SURFACE-MOUNT PACKAGES

Synergy's surface-mount RF signal processing components are manufactured under a stringent quality assurance program and are designed to meet their published specifications, unless otherwise noted, over the operating temperature range of -20°C to +70°C and after exposure to the applicable environmental tests of MIL-STD-202F.

Exposure Test	Package Outline (102S, 124S, 124SL 139 147)	Package Outlines (129, 133, 152, 134, 134S, 174S, 161, 165S)	Package Outline 154, 156, 159
	Method/Test Condition	Method/Test Condition	Method/Test Condition
Salt Spray (Corrosion)	---	---	---
Humidity	103 (90-95% RH, 40°C) (96 hrs.)	103 (90-95% RH, 40°C) (96 hrs.)	103 (90-95% RH, 40°C) (96 hrs.)
Altitude	105/G (656,000 feet)	105/G (656,000 feet)	105/G (656,000 feet)
Thermal Shock	107/B (-55°C to +85°C)	107/B (-55 °C to +85°C)	107/B (-55°C to +85°C)
Life Test	108/D	108/D	108/D
Seal	112/D	---	---
High Frequency Vibration	204/D (10-2000 HZ, 20G) (12 hrs.)	204/D (10-2000 HZ, 20G) (12 hrs.)	204/D (10-2000 HZ, 20G) (12 hrs.)
Solderability	208 (95% coverage)	208 (95% coverage)	208 (95% coverage)
Resistance to Solder Heat	210/B (260°C, 10 sec.)	210/B (260°C, 10 sec.)	210/B (260°C, 10 sec.)
Terminal Strength	---	---	211/A (2 lbs, 10 sec)
Terminal Fatigue	---	---	211/C (1 lb, 3 cycles)
Mechanical Shock	213/I (100G, 6 mS)	213/I (100G, 6 mS)	213/I (100G, 6 mS)
Random Vibration	214/2F (15 min.)	214/2F (15 min.)	214/2F (15 min.)
Resistance to Solvents	215	215	215

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SURFACE MOUNT COMPONENTS

Surface-mounting of components saves critical space on the circuit board, can result in more reliable circuits and systems, and can reduce the cost of production through automated circuit fabrication. And since circuit densities are increasing as more and more functions are combined within the confines of a finite amount of space, surface mounting looks more appealing all the time.

Surface mounting and its benefits

Unlike familiar flatpacks and plug-in packages, surface mount components do not require the PC board to be machined (drilled, routed, punched, etc.), and thus, eliminate special handling considerations. In addition, the components may be placed on the circuit board with automated "pick and place" equipment, saving an enormous amount of manpower while significantly increasing productivity and circuit yield.

No holes or cutouts are needed, as is the case with using other package styles, such as flatpacks or through hole mount. Components can be mounted to both sides of the printed circuit board, making better use of circuit board area. The height of most surface mount components is also much lower than most other component types. This combined with the area reduction, contributes to significant circuit volume reduction. Circuit fabrication can be automated.

There are also electrical performance benefits to using surface mount components. Inductance and stray capacitances are lower, due to elimination of series connecting leads and glass to metal seals. Recent advances in surface-mount technology have also added EMI/RFI shielding to many surface-mount package styles, making them exceed the performance of other package styles well into the microwave range.

Compare these advantages to the traditional package styles, and you can see why surface mounting has become so popular.

Fabrication considerations

Like any package configuration, surface mounting has its own requirements, which if followed scrupulously, will produce extremely reliable mounting.

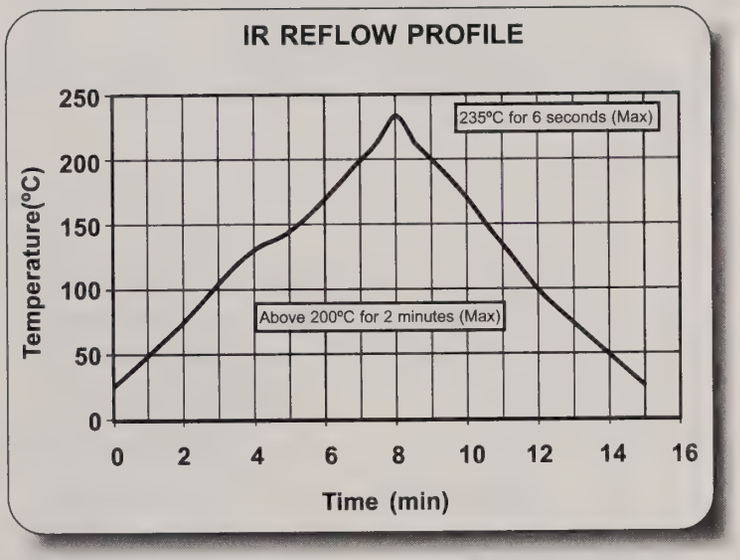
For high volume applications, tape and reel specifications must first be considered and the pick and place equipment must be programmed for proper and accurate feeding of the tape into the pick and place machines. Tape and reel information, component placement and orientation for specific models are given in this catalog.

Coplanarity is a concern with surface mount technology, and is more prominent with leaded packages. Synergy components are generally less than 0.003 inches (0.006 inches on gull-wing surface mount models, such as in the TW series of transformers). Leadless packages have the pad connections in the same plane, etched on the substrate and coplanarity is not usually of concern. As the size of surface mount packages increases, due to higher and higher circuit densities, coplanarity is more difficult to control.

Clean surface of the component leads/pads and circuit board is essential for reliable solder connections. Proper storage and handling precautions must be exercised to minimize contaminants and oxides. Flux should be used in the soldering operation to enhance solderability.

There are various soldering methods available which can be used to assemble surface-mount components. Synergy recommends vapor phase solder re-flow because it produces rapid, uniform heating of the assembly and melting of the solder. It is the cleanest method, and generally produces the best overall results. The infrared method in comparison, provides far less even heating, because some parts of a component can be in a shadow (infrared is after all light). Other sections of the component can be overheated. Consequently, yield is usually lower, and reliable solder joints are not as easy to ensure. The conducted heat method inherently provides less control over the heating process, and is subject to more variables than any other method. It is the least acceptable method.

The re-flow temperature profile should be monitored to insure that surface mount components are not being overheated. Proper planning and experimentation is necessary to optimize the soldering process. Small components heat up quicker than larger components and an optimum temperature must be established. With infrared heating, temperature probes should be placed on various points of the printed circuit board assembly, to insure that components are not being overheated. In some extreme cases, soldering of the larger components may have to be done by hand, after the assembly of the smaller components. Larger components may shadow smaller components from the heat source. The recommended solder profile for Synergy products follows.



Aqueous cleaning after the soldering operation is now used extensively, due to new environmental laws. A concern arises for non-hermetic surface mount components, where moisture can penetrate to the inside of the components and degrade the electrical performance. A cool down period of approximately one hour should be allowed after soldering and prior to cleaning. If necessary, a stabilization bake should be performed to remove any moisture that may have seeped into the inside.

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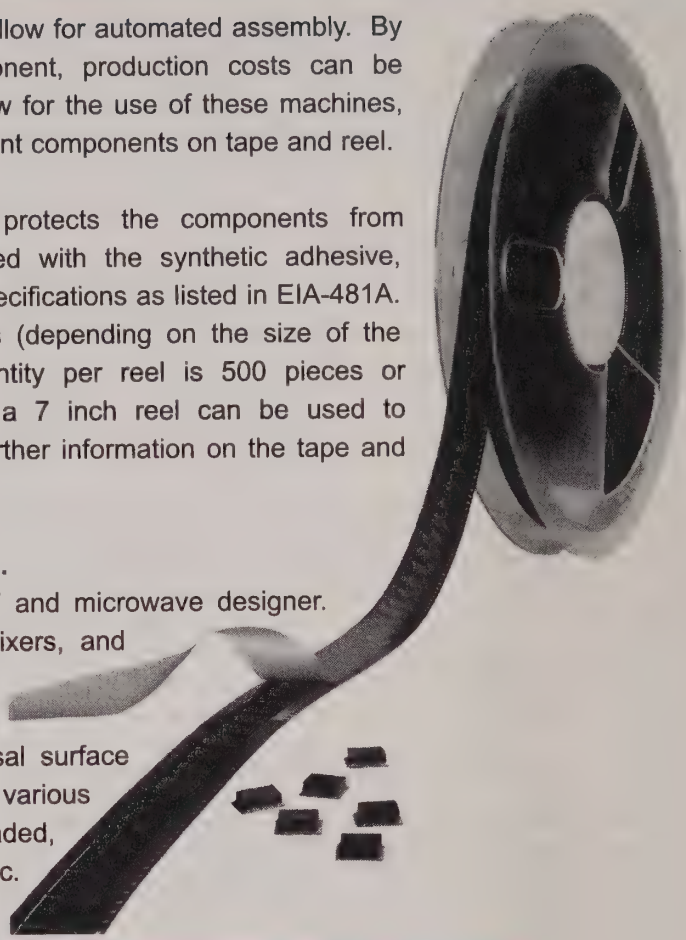
TAPE AND REEL

The main calling card for surface-mount components is to allow for automated assembly. By optimizing the small design of the surface mount component, production costs can be minimized with the use of pick and place machines. To allow for the use of these machines, Synergy offers the option of receiving most of the surface mount components on tape and reel.



Each reel uses thermoplastic film construction which protects the components from electrostatic charge or field induced effects. When sealed with the synthetic adhesive, nonconductive cover tape, the components conform to the specifications as listed in EIA-481A. The reels are capable of holding from 100 to 1000 pieces (depending on the size of the component.) In most cases, the minimum required quantity per reel is 500 pieces or the maximum for larger components. In special cases, a 7 inch reel can be used to accomodate smaller quantities. The following page gives further information on the tape and reel specifications.

Synergy offers many types of surface-mount components.

Synergy pioneered surface-mount components for the RF and microwave designer. We were the first company to introduce surface-mount mixers, and today have a complete family of surface-mount mixer products in most popular combinations of electrical performance. Synergy has earned a patent for a "universal surface mount package", and in its extensive product line offers various surface-mount package styles to choose from such as - leaded, leadless, ceramic, plastic, EMI/RFI shielded and hermetic. Custom requirements can easily be accomodated.

We also offer the following components in the various surface-mount packages:

- *Voltage controlled oscillators*
- *Frequency synthesizers and phase locked oscillators*
- *I&Q modulators/demodulators*
- *Image reject mixers*
- *QPSK modulators*
- *Phase shifters*
- *Filters - low pass, bandpass, highpass*
- *Phase detectors*
- *Phase comparators*
- *Directional couplers*
- *Power dividers*
- *BPSK modulators*
- *Frequency doublers*
- *Quadrature hybrids*
- *Transformers*

Contact SYNERGY if the tape and reel specification you need is not in this standard catalog.

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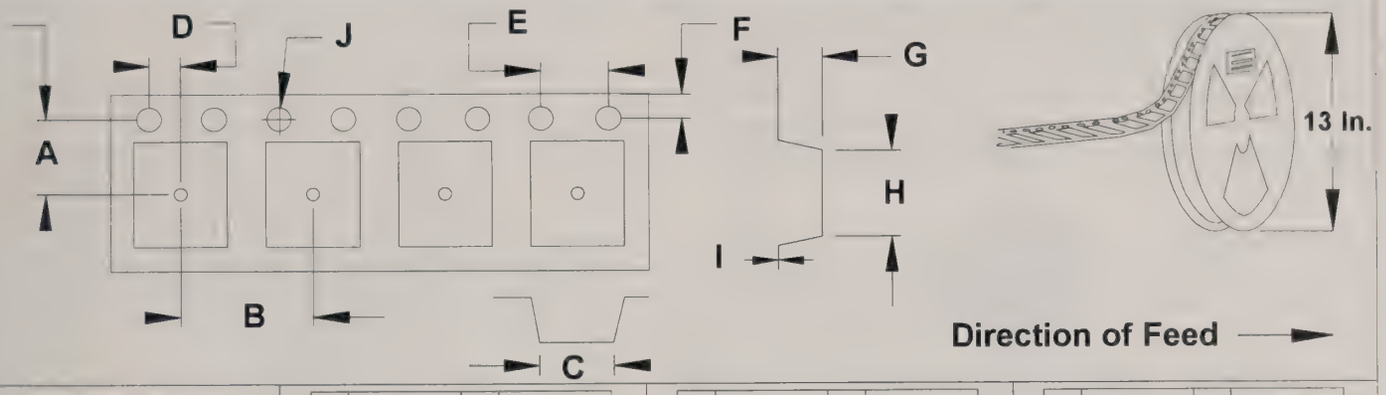
TAPE AND REEL SPECIFICATIONS

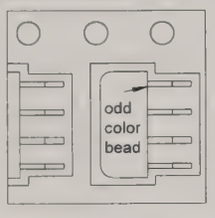


Tolerances:

For W < 1.0"	For W >1.0"
A = +/-0.005"	A = +/-0.015"
B = +/-0.005"	B = +/-0.010"
C = +/-0.005"	C = +/-0.014"
D = +/-0.005"	D = +/-0.006"
E = +/-0.004"	E = +/-0.004"
F = +/-0.005"	F = +/-0.005"
G = +/-0.005"	G = +/-0.004"
H = +/-0.005"	H = +/-0.005"
I = +/-0.0005"	I = +/-0.0005"
J = +0.004" (-0.000")	J = +0.004" (-0.000")
W=+0.012" (-0.004")	W=+0.012" (-0.004")

A	0.453	G	0.251
B	0.630	H	0.516
C	0.472	I	0.0135
D	0.079	J	0.061
E	0.158		
F	0.069		

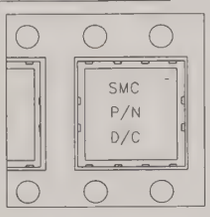
106B



W=0.945"

A	0.795	G	0.446
B	1.257	H	0.971
C	0.970	I	0.0165
D	0.079	J	0.0591
E	0.158		
F	0.069		

124S, 124SL



W=1.732"
(+/-0.012)

A	0.453	G	0.155
B	0.472	H	0.339
C	0.400	I	0.0135
D	0.079	J	0.059
E	0.158		
F	0.069		

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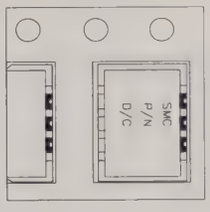
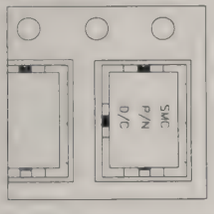


W=0.945"

A	0.453	G	0.155
B	0.472	H	0.339
C	0.400	I	0.0135
D	0.079	J	0.059
E	0.158		
F	0.069		

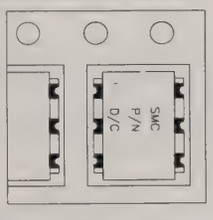
133



W=0.945"

A	0.295	G	0.206
B	0.472	H	0.339
C	0.276	I	0.0135
D	0.079	J	0.059
E	0.158		
F	0.069		

134



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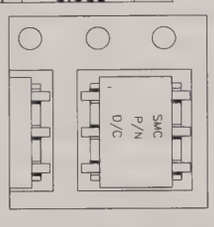
C	0.340	I	0.014
D	0.079	J	0.059
E	0.157		
F	0.069		

134S,134J



W=0.63 "

A	0.453	G	0.155
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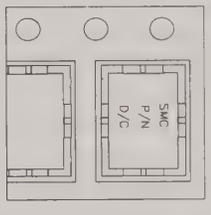
C	0.400	I	0.0135
D	0.079	J	0.059
E	0.158		
F	0.069		

139



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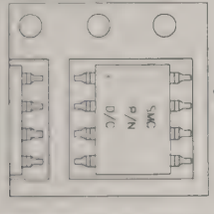
B	0.630	H	0.430
C	0.425	I	0.014
D	0.079	J	0.059
E	0.157		
F	0.069		

154



W=0.945"

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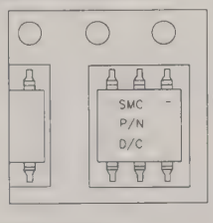
B	0.472	H	0.457
C	0.343	I	0.014
D	0.079	J	0.059
E	0.158		
F	0.069		

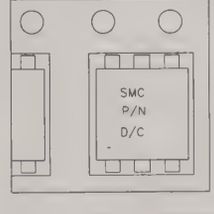
156



W=0.945"

A	0.453	G	0.244
B	0.472	H	0.457
C	0.343	I	0.014
D	0.079	J	0.059
E	0.158		
F	0.069		

159



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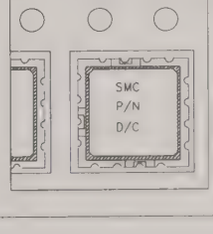
C	0.515	I	0.0135
D	0.079	J	0.059
E	0.158		
F	0.069		

174S



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VOLTAGE CONTROLLED OSCILLATORS

INTRODUCTION

In simple terms, an oscillator is an amplifier where sufficient energy is coupled back from the output to the input to become unstable and start oscillating. The output port then provides the wanted output power into the load and the overall circuit configuration determines the frequency stability and sensitivity to load changes. Figure 1 shows the feedback arrangement.

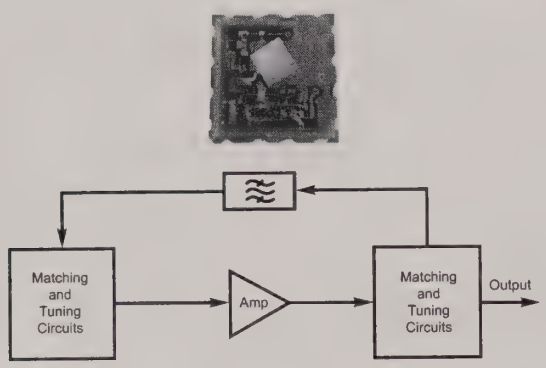

Figure 1 — An oscillator viewed as a feed-forward amplifier with positive feedback through the resonator. Start-up of oscillation requires that the gain of the amplifier exceed the loss of the resonator and that the total phase shift through the amplifier and resonator be a multiple of 360°. To sustain oscillation, the phase shift must remain the same and the amplifier gain must be equal to or greater than the resonator loss.

While there are several configurations possible, the most popular oscillator configuration up to very high frequencies is the Clapp oscillator circuit. Practically all high performance oscillators with wide tuning range follow this basic configuration. Energy can be coupled either from the collector or from the emitter of a BJT oscillator. The same basic concept applies to an oscillator using a silicon junction FET. The use of GaAsFETs is reserved for high microwave and millimeterwave applications, typically above 10 GHz. The principle of operation of this circuit is that the feedback loop generates a negative impedance (negative resistive part) which compensates for all the losses. The sum of all the resistive elements must still be slightly negative. This condition of the modified Barkhausen equation has to be met to start and maintain oscillation.

The following is an interpretation to calculate the conditions necessary for oscillation. It is based on the fact that an ideal tuned circuit (infinite Q), once excited, will oscillate infinitely because there is no resistance element present to dissipate the energy. In the actual case (where the inductor Q is finite), the oscillations die out because energy is dissipated in the resistance. It is the function of the amplifier to maintain oscillations by supplying an amount of energy equal to that dissipated. This source of energy can be interpreted as a negative resistor in series with the tuned circuit. If the total resistance is positive, the oscillations will die out, while the oscillation amplitude will increase if the total resistance is negative. To maintain oscillations, the two resistors must be of equal magnitude. To see how a negative resistance is realized, the input impedance of the circuit in Figure 2 will be derived. Figure 3 shows an equivalent small signal circuit of Figure 2.

The steady-state loop equations are

$$V_{in} = I_{in}(X_{C_1} + X_{C_2}) - I_b(X_{C_1} - \beta X_{C_2}) \quad (1)$$

$$0 = -I_{in}(X_{C_1}) + I_b(X_{C_1} + h_{ie}) \quad (2)$$

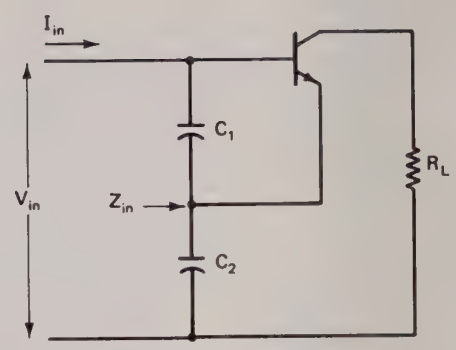

Figure 2 — Calculation of input impedance of the negative-resistance oscillator.

After I_b is eliminated from these two equations, Z_{in} is obtained as

$$Z_{in} = \frac{V_{in}}{I_{in}} = \frac{(1+\beta)X_{C_1}X_{C_2} + h_{ie}(X_{C_1} + X_{C_2})}{X_{C_1} + h_{ie}} \quad (3)$$

if $X_{C1} \ll h_{ie}$, the input impedance is approximately equal to

$$Z_{in} \approx \frac{1+\beta}{h_{ie}} X_{C_1}X_{C_2} + (X_{C_1} + X_{C_2}) \quad (4)$$

$$Z_{in} \approx \frac{-g_m}{\omega^2 C_1 C_2} + \frac{1}{j\omega[C_1C_2/(C_1+C_2)]} \quad (5)$$

That is, the input impedance of the circuit shown in Figure 3 is a negative resistor,

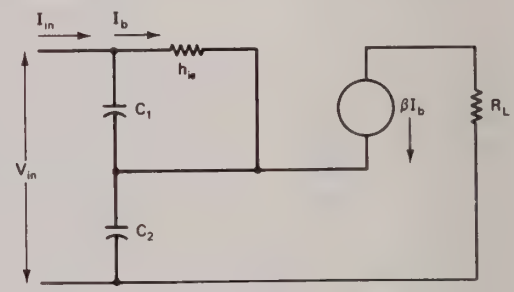

Fig. 3 - Equivalent small-signal circuit of Figure 2.

$$R = \frac{-g_m}{\omega^2 C_1 C_2} \quad (6)$$

in series with a capacitor,

$$C_{in} = \frac{C_1 C_2}{C_1 + C_2} \quad (7)$$

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which is the series combination of the two capacitors. With and inductor L (with the series resistance R_s) connected across the input, it is clear that the condition for sustained oscillation is

$$R_s = \frac{g_m}{\omega^2 C_1 C_2} \tag{8}$$

and the frequency of oscillation

$$f_o = \frac{1}{2\pi\sqrt{L[C_1C_2/(C_1+C_2)]}} \tag{9}$$

This interpretation of the oscillator readily provides several guidelines which can be used in the design. First, C_1 should be as large as possible so that

$$X_{C_1} \ll h_{ie}$$

and C_2 is be large so that

$$X_{C_2} \ll \frac{1}{h_{oe}}$$

when these two capacitors are large, the transistor base-to-emitter and collector-to-emitter capacitances will have a negligible effect on the circuit's performance. However, Eq. (8) limits the maximum value of the capacitances since

$$r \le \frac{g_m}{\omega^2 C_1 C_2} \le \frac{G}{\omega^2 C_1 C_2} \tag{10}$$

where G is the maximum value of g_m. For a given product of C_1 and C_2, the series capacitances is a maximum when $C_1 = C_2 = C_m$. Thus Eq. (10) can be written

$$\frac{1}{\omega C_m} > \sqrt{\frac{r}{G}} \tag{11}$$

This equation is important in that it shows that for oscillations to be maintained, the minimum permissible reactance ($1/\omega C_m$) is a function of the resistance of the inductor and the transistor's mutual conductance g_m.

An oscillator circuit known as the *Clapp* circuit or *Clapp-Gouriet* circuit is shown in Figure 4. This oscillator is equivalent to the one just discussed, but it has the practical advantage of being able to provide another degree of design freedom by making C_o much smaller than C_1 and C_2. It is possible to use C_1 and C_2 to satisfy the condition of Eq. (10) and then adjust C_o for the desired frequency of oscillation ω_o which is determined from

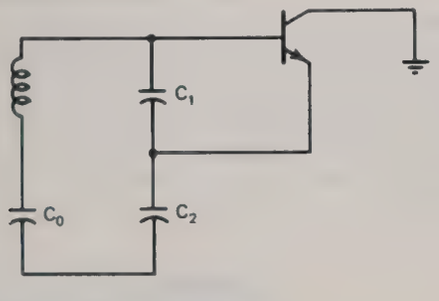

Fig. 4 — Circuit of Clapp oscillator.

For frequency applications above several hundred MHz, the discrete inductance is exchanged to be a transmission line, and for even higher frequencies (such as 800 MHz and higher), a ceramic resonator of high Q is the best choice. Also, one can use SAW oscillators (surface acoustic wave resonators) and dielectic-resonator-based oscillators.

$$\omega_o L - \frac{1}{\omega_o C_o} - \frac{1}{\omega_o C_1} - \frac{1}{\omega_o C_2} = 0 \tag{12}$$

These types of oscillators can be made voltage controlled oscillators by changing capacitor C_o from a fixed value to a voltage dependent capacitor, commonly referred to as tuning diode or varactor. The use of just a single diode is typically discouraged. For small DC voltages, the tuning diode becomes conductive in the positive half of the sine wave, and this reduces the Q and deteriorates the phase noise performance. As a minimum, a high-performance oscillator requires one set of anti-parallel diodes. A high-performance VCO is shown in Figure 5. A more detailed introduction to designing VCOs is found in References 1 and 2.

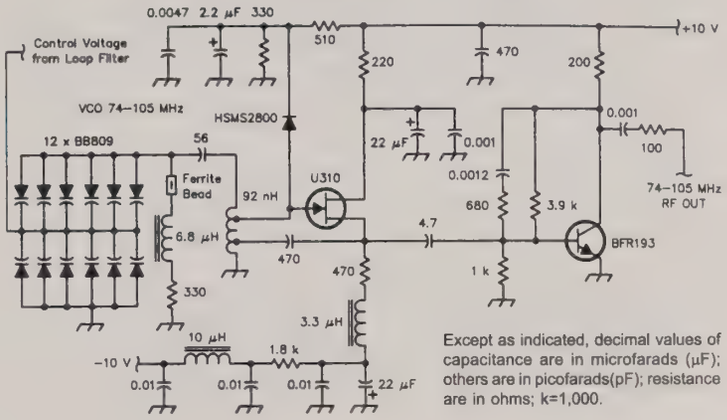

Fig. 5 — Improved phase-noise performance can be obtained by using a number of tuning diodes in the antiparallel arrangement shown here. The 92-nH coil is a 4-turn coil tapped at 1 and 2 turns from the ground end.

Wideband VCOs vs. Narrowband VCOs

The tuning range of an oscillator is determined by the amount of fixed capacitance versus available capacitance in the circuit. In many cases (such as in cellular telephone applications), the tuning range required is limited to 5% (for example, 50 MHz relative to 1000 MHz). Some applications require ranges of up to 2:1, however. In these cases, tuning diodes with a high capacitance range are required. These diodes are frequently referred to as hyperabrupt diodes. The drawback of hyperabrupt diodes is that their transfer characteristics, or change of capacitance as a function of voltage, is not very linear.

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Figure 6 shows the capacitance voltage characteristic for three different types of diodes. The operating range of the capacitance diode or (its useful capacitance ratio) is limited by the requirement that the diode must not be driven into forward conduction or breakdown by the RF voltage superimposed on the tuning voltage. Otherwise, rectification would take place, shifting the bias of the diode and considerably affecting its figure of merit.

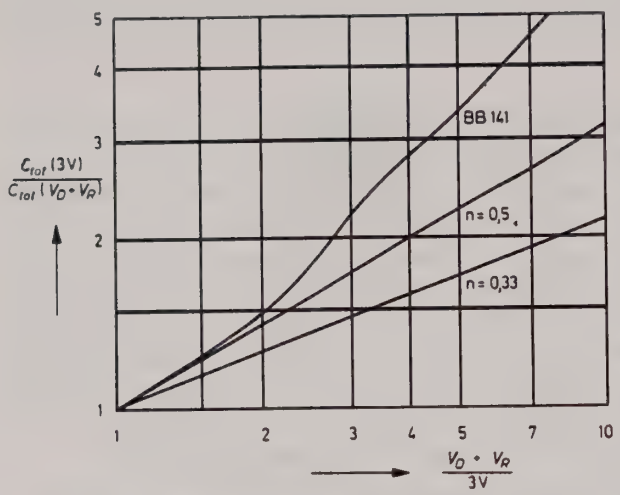

Fig. 6 — Capacitance/voltage characteristic for
a) an alloyed capacitance diode
b) a diffused capacitance diode
c) a wide-range tuner diode (BB141)

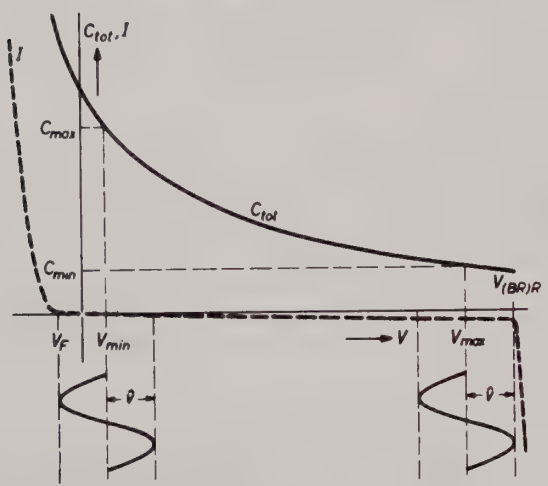

Fig. 7 — Basic current/voltage and capacitance/voltage characteristics of a tuning diode.

As a result of a high alternating voltage at the resonant circuit, capacitance contributed by tuning diodes may produce three undesirable effects:

1) The nonlinearity of the capacitance may generate more harmonics than the oscillator circuit produces by itself. The RF voltage across the diodes should therefore be kept small.

2) Even when a sinusoidal voltage is applied to the tuning diodes, their capacitance variation does not follow the sine law. Depending on the amplitude of the applied voltage, this may result in a change of the resonator frequency. Under certain conditions, this can even lead to bistable behavior, and the oscillator may show an effect called *squegging*.

3) Intermodulation, a disturbance caused by nonlinearities in the diode characteristics, is virtually independent of the oscillator amplitude. It can result in the transfer of an undesired signal (noise) to the oscillator output signal (carrier). The undesired signal is the noise internally generated by the oscillator transistor(s). This intermodulation, the mechanism of which is also referred to as *AM-to-PM conversion*, occurs in BJT PN and NP junctions and their FET equivalents.

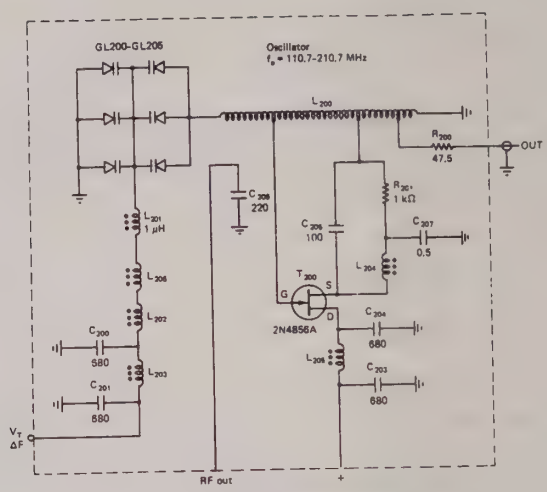

Fig. 8 — Practical circuit of a wideband VCO.

Phase Noise

One of the key characteristics of the oscillator is the oscillator noise frequently referred to as single *side-band phase noise.*

Oscillator Noise

The SSB phase noise of an oscillator is well described by the Leeson model and its enhancements. Leading engineers such as M. Driscoll of Westinghouse and Tom Parker of Raytheon have expanded the model to include the flicker-noise component even of passive components. The enhanced Leeson equation, as proposed by Parker and others, is shown in Figure 9.

$$S_\phi(f_m) = \left[\alpha_R F_o^4 + \alpha_E \left(F_o / (2Q_L)\right)^2\right] \Big/ f_m^3 + \left[(2GFKT / P_o)\left(F_o / (2Q_L)\right)^2\right] \Big/ f_m^2 + (2\alpha_R Q_L F_o^3) \Big/ f_m^2 + \alpha_E / f_m + 2GFKT / P_o$$

Fig. 9 — The Leeson equation for oscillator phase noise. *G* is the compressed power gain of the loop amplifier, *F*, is the noise factor of the loop amplifier, *K* is Boltzmann's constant, *T* is the temperature in Kelvins, P_o is the carrier output power, in watts, at the output of the loop amplifier, F_o is the carrier frequency in hertz, f_m is the carrier offset frequency in hertz, Q_L is the loaded Q of the resonator in the feedback loop, and α_R and α_E are the flicker noise constants for the resonator and loop amplifier, respectively.

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Numerous circuits have been developed to implement oscillators. These circuits have various advantages and disadvantages, depending on the frequency of operation and the resonator type. For circuits in the 400 to 2000 MHz range, modern oscillators tend to use transmission-line resonators and capacitive feedback of the Colpitts or Clapp type. At these frequencies, bipolar transistors are generally used, since few FETs have sufficient gain-bandwidth product for use in UHF oscillator circuits.

Requirements for Low-Noise Oscillators — The key elements that determine the phase noise of an oscillator are:

- the transistor's flicker-noise corner frequency, which depends on the device current;
- the loaded Q of the resonator, which depends on the coupling between the resonator and the transistor; and
- the ultimate signal-to-noise ratio, which depends on the RF output power of the oscillator and its large-signal noise figure.

Of these, the first two can be investigated using linear circuit analysis. But the active device's large-signal operation requires nonlinear analysis techniques, without which we can make only educated approximations of the ultimate signal-to-noise ratio.

The Linear Approach

The design goal of the linear approach is to achieve the maximum loaded Q of the resonator and to keep the bias (DC) device current to a minimum. A high Q helps restrict noise components to frequencies close to the frequency of oscillation, minimizing phase noise as we move away from that frequency. The requirement for minimum bias exists because the flicker, or 1/f, noise of the device is highly dependent on the current. Table 1 shows the flicker-noise corner frequency versus collector current for a typical bipolar transistor. JFETs have much less flicker noise than bipolar tansistors, while GaAsFETs have more.

Table 1 - Flicker Corner Frequency vs. Collector Current for a Typical Bipolar Transistor

I_c (mA)	F_c (kHz)
0.25	1
0.5	2.74
1	4.3
2	6.27
5	9.3

Oscillator Operation — At start-up, the oscillator's open-loop gain must be sufficient to begin oscillation. The circuit's amplitude stabilization mechanism is responsible for sustaining oscillation. We can view the oscillator as a two-terminal negative-resistance generator, as shown in Figure 10. Here, the total resistance—the sum of the resonator resistance and the resistance of the two-terminal oscillator—must be less than or equal to zero for oscillation. The net reactance will be zero at resonance.

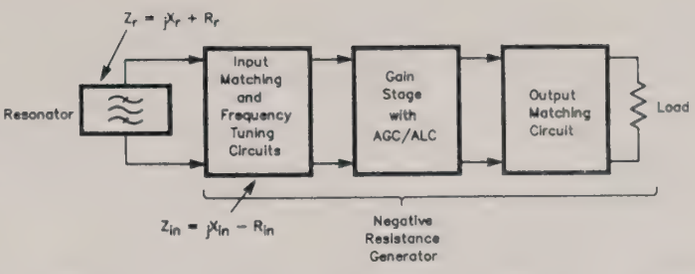

Fig. 10 - An oscillator viewed as a resonator and a negative resistance generator. At start-up, the resonator and oscillator reactances must be equal in value and opposite in sign, while the sum of the resonator and oscillator resistances must be less than 0. For sustained oscillation, the sum of the resistances must not become positive.

Although we can't precisely analyze the large-signal operation of a circuit using wholly linear techniques, we should recognize some effects that will impact our linear analysis. Chief among these is bias shift. The large signals present in the circuit in a bipolar oscillator will cause a shift in the bias current, because of the nonlinearity of the base-emitter junction. The device current may be about 10% different from the nominal (no-signal) current and may shift in either direction (more current or less). Since the flicker noise is bias-dependent, this effect is important to keep in mind.

The recommended approach to finding the bias-dependent loading of the resonator by the active device is to construct a linearized model of the device using its measured S-parameters at a particular bias point. This is especially important at higher frequencies. For simplicity, we have chosen not to do this in the example that follows, but to use a simple model.

Over a wide range of current, the device f_t remains constant. Since:

$$f_t = \frac{1}{2\pi R_d C_e} \tag{13}$$

where R_d is the emitter diffusion resistance and C_e is the emitter capacitance, and since:

$$R_d = \frac{26\ \text{mV}}{I_E} \tag{14}$$

(at room temperature), where I_E is the emitter bias current, we can therefore adjust the R_d and C_e parameters of our device model to reflect the bias current we expect to use. This will allow our linear circuit model to reflect the bias dependency of the oscillator.

As mentioned before, flicker noise is dependent largely on the bias current. But the *effect* of flicker noise can be reduced. This noise contributes to the phase noise by modulating the oscillator's frequency via AM-to-PM conversion. We can reduce this modulation by use of negative feedback. A simplified noise model of a transistor is shown in Figure 11.

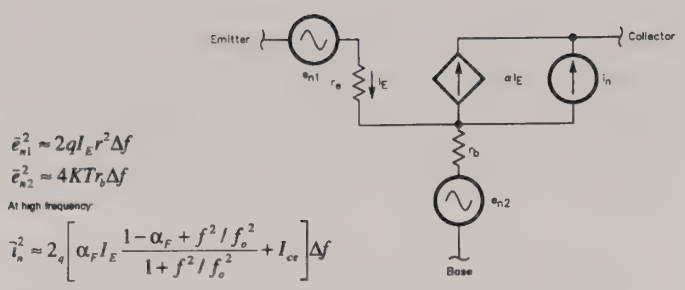

Figure 11 — A simplified bipolar transistor noise model with white-

The effect of applying negative feedback to reduce phase noise is shown in Figure 12.

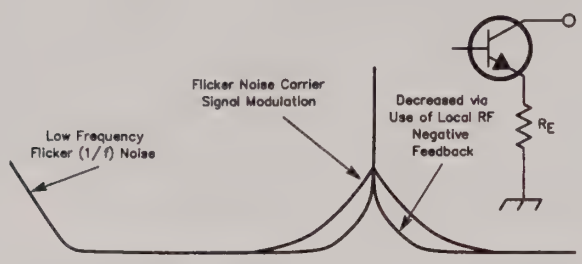
Flicker Noise Carrier Signal Modulation
Decreased via Use of Local RF Negative Feedback
Low Frequency Flicker (1/f) Noise
R_E

Fig. 12 — Adding negative feedback can reduce the amount of AM-to-PM modulation of the carrier by the transistor's flicker noise.

VCO Noise — So far, we have considered only the noise from the transistor. When we extend our design to become a VCO, by adding a tuning diode, we must also consider the phase noise introduced by that diode. Contrary to what you may have read elsewhere, this noise is not due solely to Q reduction from the added diode. The diode itself introduces noise that modulates the VCO frequency. The easiest way to analyze this noise is to treat the diode's noise contribution as that of an equivalent resistance, R. This resistor can then be considered to be generating the thermal noise voltage that any resistance exhibits:

$$V_n = \sqrt{4KT_0R\Delta f} \qquad (15)$$

where V_n is the open-circuit RMS thermal noise voltage across the diode, K is Boltzmann's constant, T_0 is the temperature in Kelvins, R is the equivalent noise resistance of the tuning diode, and Δf is the bandwidth we wish to consider. At room temperature (about 300 K), KT_0 is 4.2×10^{-21}.

Practical values of R for tuning diodes range from about 1 kΩ to 50 kΩ. For a value of 10 kΩ, for example, we would find a noise voltage from Eq. 15 of:

$$V_n = \sqrt{4\times4.2\times1-^{21}\times10{,}000}$$
$$= 1.265\times10^{-8}\ \ \mathrm{V}/\sqrt{\mathrm{Hz}}$$

This noise voltage from the tuning diode modulates the frequency of the oscillator in proportion to the oscillator's VCO gain, K_0, (the frequency swing per volt of the tuning signal):

$$(\Delta f_{rms}) = K_0 \times (1.265\times10^{-8}\,\mathrm{V}) \qquad (16)$$

in a 1-Hz bandwidth. This can be related to the peak phase deviation, θ_d :

$$\theta_d = \frac{K_0\sqrt{2}}{f_m}(1.265\times10^{-8}\,\mathrm{rad}) \qquad (17)$$

in a 1-Hz bandwidth, where f_m is the frequency offset of the noise from the oscillator operating frequency. Applying a typical VCO gain of 100 kHz/V gives a typical peak phase deviation of:

$$\theta_d = \frac{0.00179}{f_m}\,\mathrm{rad} \qquad (18)$$

in a 1-Hz bandwidth. For an offset of 25 kHz, as might be used to find the noise in an adjacent FM channel, this gives $\theta_d = 7.17\times10^{-8}$ rad in a 1-Hz bandwidth. Finally, we can convert this result into the SSB signal-to-noise ratio at the specified frequency offset:

$$L(f_m) = 20\log_{10}\frac{\theta_d}{2} = -149\,\mathrm{dBc/Hz} \qquad (19)$$

It is also worth noting that the nonlinear capacitance vs. voltage characteristic of a tuning diode results in a tuning sensitivity—and thus a noise performance—that depends on the input tuning voltage. Modern CAD tools can help in the analysis of an oscillator.

Figure 13 shows the circuit of a typical 950 MHz ceramic resonator based oscillator.

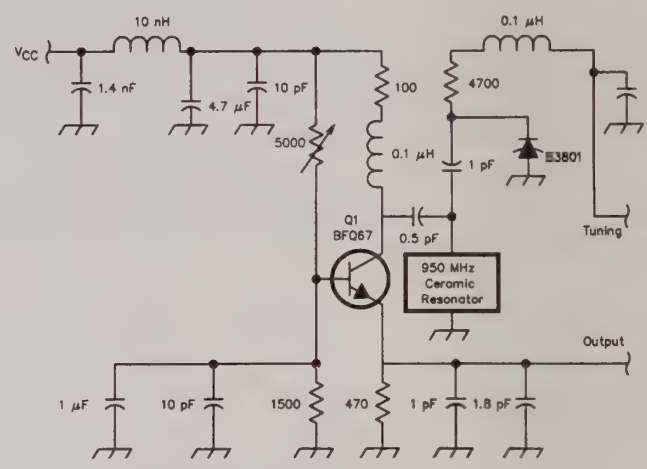

Fig. 13 — Circuit of typical 950-Mhz ceramic resonator based oscillator.

Figure 14a shows its measured performance while Figure 14b shows its CAD prediction. As can be seen from Figure 15, phase noise increases as the tuning sensitivity of the VCO is increased.

While oscillator design is done at Synergy Microwave, we have extensive use of CAD tools, such as Compact Software's Microwave Harmonica.

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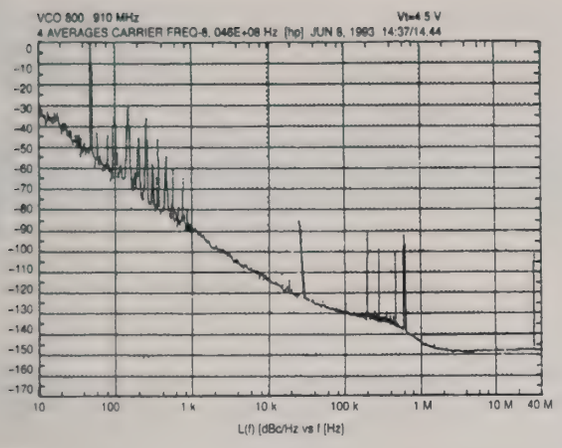

Fig. 14a — Measured phase noise of the oscillator of Figure 13.

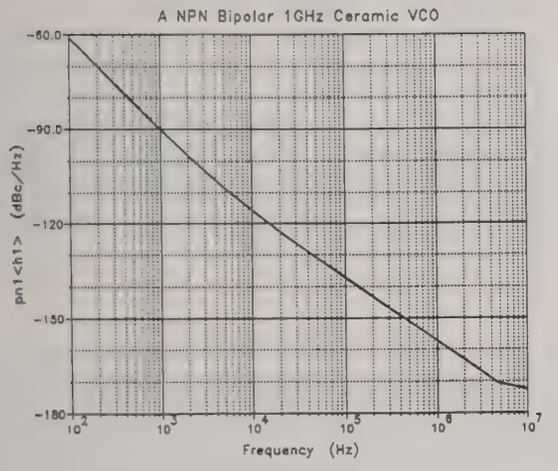

Fig. 14b — Predicted phase noise of the 1-GHz ceramic resonator VCO with the tuning diode attached. Note the good agreement between the measured and predicted phase noise.

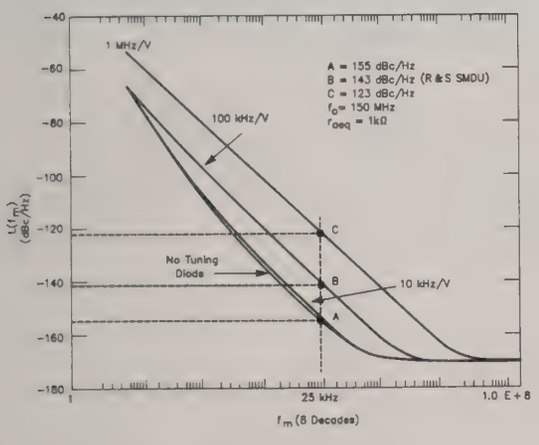

Fig. 15 — Phase noise increases as the tuning sensitivity of the VCO is increased, as shown here ($r_{eeq.}$ is the equivalent noise resistance of the tuning diode).

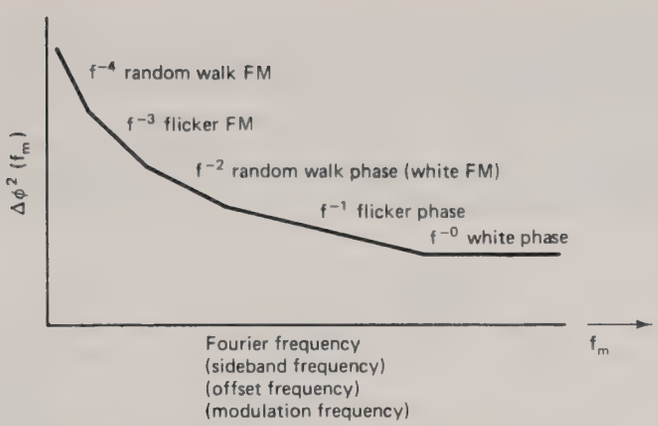

Fig. 16 — Characterization of noise sideband in the frequency

VCO TERMINOLOGY

In specifying VCOs, the following list of definitions may help to get a better understanding of what to look for:

VCO (Voltage Controlled Oscillator): The output frequency of the oscillator is determined by a DC control voltage. This applied voltage tunes the oscillator over a specified range.

Phase noise: This term describes the "single sideband phase noise" of the oscillator. It is composed of noise close to the carrier (flicker noise) and noise measured at a spacing of 20 kHz and greater. The flicker noise measured in a VCO is generated only by the active devices, such as the transistor and the tuning diode. For silicon junction FET, the flicker corner frequency is typically at 50 Hz to 100 Hz. Microwave bipolar transistors have a flicker corner frequency of up to 5 kHz. More exotic devices, such as heterojunction bipolar transistors (HBTs), have flicker corner frequencies up to 50 kHz but also have f_T corner frequencies of up to 100 Hz. Finally, GaAsFETs have a corner frequency of several megahertz. The phase noise is measured at distances from 1 Hz off the carrier to several megahertz off the carrier in a 1-Hz bandwidth. Phase noise is the ratio of the output power divided by the noise power at a specified value and is expressed in dBc/Hz. Figure 16 shows a typical phase-noise plot. The area between the flicker corner frequency and the residual noise flow is proportional to $1/Q^2$ and is only determined by the quality of the resonator.

Output power: The output power of the oscillator, typically expresssed in dBm, is measured into a 50-Ω load. The output power is always combined with a specification for flatness or variation. A typical spec would be 0 dBm output power ±1 dB tolerance.

Output power as a function of temperature: All active circuits change in their behavior as a function of temperature. The output power over a temperature range should vary less than a specified value, such as 1 dB.

Harmonic output power: The harmonic content is measured relative to the output power. Typical values are 20 dB suppression or more relative to the fundamental. This suppression can be improved by additional filtering.

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Spurious outputs: A VCO's spurious output specification, expressed in decibels, enumerates the strength of unwanted and nonharmonically related components relative to the oscillator fundamental. Because a stable, properly designed oscillator is inherently clean, such *spurs* are typically introduced only by external sources in the form of radiated or conducted interference. *See Harmonic output power.*

Frequency tuning characteristic: This shows the relationship, depicted as a graph, between a VCO's operating frequency and the tuning voltage applied. Ideally, the correspondence between operating frequency and tuning voltage is linear. *See Tuning linearity.*

Tuning linearity: For stable synthesizers, a constant deviation of frequency versus tuning voltage is desirable. It is also important to make sure that there are no breaks in the tuning range—for example, that the oscillator does not stop operating with a tuning voltage of 0. *See Frequency tuning characteristic.*

Tuning performance: This datum, typically expressed in megahertz per volt (MHz/V), enumerates how much a VCO's frequency changes per unit of tuning-voltage change.

Tuning speed: This characteristic is defined as the time necessary for the VCO to reach 90% of its final frequency on the application of a tuning-voltage step. Tuning speed depends on the internal components between the input pin and tuning diode—including, among other things, the capacitance present at the input port. The input port's parasitic elements determine the VCO's maximum possible modulation bandwidth.

Post tuning drift: After a voltage step is applied to the tuning diode input, the oscillator frequency may continue to change until it settles to a final value. This post tuning drift is one of the parameters that limits the bandwidth of the VCO input.

Temperature drift: Although the synthesizer is responsible for locking and maintaining the oscillator's frequency, the VCO's frequency change as a function of temperature is a critical parameter and must be specified. Its value varies between 10 kHz/°C to several hundred kHz/°C depending on the center frequency and tuning range.

Sensitivity to load changes: This is called *frequency pulling* and the change of frequency resulting from a partially reactive load. Dividing from 50 Ω is used as a determination. Frequency pulling must be minimized, especially in cases where power stages are close to the VCO unit and short pulses may affect the output frequency. Such feedback may make locking impossible.

Frequency pushing: This is another case of the oscillator frequency being affected by external influences, typically by supply voltage. Taking the same example as above, a sudden current surge caused by the output amplifier of a two-way radio may produce a spike on the VCO's DC power supply and a consequent frequency jump.

References:

Ulrich L. Rohde, Microwave and Wireless Synthesizers: Theory and Design, *to be published August, 1997 by John Wiley & Sons, New York, NY, ISBN: 0471-52019-5*

Ulrich L. Rohde, KA2WEU, "Designing Low-Phase-Noise Oscillators," QEX, *October 1994.*

Ulrich L. Rohde, KA2WEU, "All About Phase Noise in Oscillators, Part III - Example oscillator circuits and their noise performance," QEX, *February 1994.*

VOLTAGE CONTROLLED OSCILLATORS

MINIATURE SURFACE-MOUNT PACKAGE

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FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
40 - 100	1 - 17	+12	<35	+8	± 2	4 - 7	-100/-125	10	1	5	**MFC40A**
50 - 100	0 - 17	+5	<35	+5	± 2	3 - 6	-105/-125	10	1	2	**MFC-S-50**
50 - 90	1 - 10	+12	<30	+7	± 1.5	5 - 8	-108/-132	12	0.35	0.5	**MFC50A12**
56 - 103	0 - 12	+12	<45	+8	± 2	5 - 10	-108/-132	12	1	5	**MFC56A**
60 - 120	0 - 17	+5	<35	+5	± 2	4 - 8	-95/-115	10	2	2	**MFC-S-60**
70 - 120	0 - 12	+5	<35	+4	± 2	5 - 8	-105/-125	10	2	5	**MFC70A**
100 - 200	0 - 17	+5	<35	+5	± 2	6 - 14	-112/-134	10	1	0.4	**MFC-S-100**
104 - 176	1 - 12	+12	<30	+10	± 2	7 - 12	-105/-125	15	1	1.5	**MFC104A**
150 - 300	0 - 17	+5	<35	+4	+ 2	10 - 20	-107/-132	10	1	0.4	**MFC-S-150**
165 - 205	1 - 12	+12	<30	+10	± 2.5	8 - 16	-105/-128	25	0.5	2	**MFC165A**
200 - 400	0 - 17	+5	<35	+5	± 2	10 - 20	-95/-118	10	2	5	**MFC-S-200**
205 - 280	0.5 - 4.5	+5	<35	+1	± 2	20 - 25	-97/-120	10	2	5	**MFC205A**
210 - 230	0.5 - 3	+3	<15	0	± 2	12 - 16	-95/-117	10	1	3	**MFC210B**
210 - 270	1 - 12	+5	<35	+5	± 2	5 - 6	-93/-117	10	2	5	**MFC210A**
225 - 412	0 - 12	+12	<45	+10	± 2	15 - 25	-100/-125	12	2	5	**MFC225A**
240 - 502	1 - 17	+5	<35	+5	± 2	16 - 28	-95/-120	10	2	7	**MFC240A**
320 - 360	1 - 7	+5	<35	+8	±1.5	9 - 14	-100/-125	15	1	5	**MFC320A**
350 - 410	2 - 10	+8	<35	+5	± 2	8 - 11	-93/-123	10	2	5	**MFC350A**
360 - 410	0.5 - 5	+5	<35	+3	± 3	12 - 18	-107/-135	15	2	5	**MFC360A**
381 - 406	1 - 5	+5	<15	+2.5	± 2.5	8 -12	-110/-133	15	1	2	**MFC381A**
400 - 450	1 - 10	+10	<20	+9	± 2	6 - 10	-110/-133	10	1	5	**MFC400A**
400 - 800	0 - 15	+5	<35	+5	± 2	20 - 30	-95/-117	10	2	5	**MFC-S-400**
437 - 461	1 - 5	+5	<15	+2.5	± 2.5	8 - 12	-110/-133	15	1	2	**MFC437A**
445 - 495	2 - 10	+12	<30	+5	± 2	6 - 10	-110/-135	30	1	5	**MFC445A**
445 - 470	1 - 5	+5	<15	+2.5	± 2.5	8 - 12	-110/-133	15	1	2	**MFC445B**
446 - 588	0.5 - 4.5	+10	<25	+6	± 3	44 - 66	-100/-125	7	1	2	**MFC446A**
467 - 492	1 - 5	+5	<15	+2.5	± 2.5	8 -12	-110/-133	15	1	2	**MFC467A**
487 - 568	0 - 12	+5	<35	0	± 2	8 - 12	-107/-130	10	2	5	**MFC487A**
490 - 560	0 - 4.5	+8	<20	0	± 2	17 - 25	-102/-125	10	1	2	**MFC490A**
500 - 1000	0.2 - 10	+5	<35	+5	± 3.5	55 - 70	-90/-112	10	3	10	**MFC500A**
511 - 536	1 - 5	+5	<15	+2	± 2	8 - 10	-110/-133	10	1	2	**MFC511A**
525 - 575	0 - 5	+5	<35	0	± 2	13 - 17	-108/-133	10	2	5	**MFC525A**
533 - 558	1 - 5	+5	<15	+2.5	± 2.5	8 - 12	-110/-133	10	1	5	**MFC533A**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

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MINIATURE SURFACE-MOUNT PACKAGE

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
550 - 590	1 - 11	+12	<50	+11	± 2	4 - 6	-107/-130	12	5	5	MFC550A
560 - 760	3 - 20	+12	<20	+5	± 3	15 - 20	-105/-125	10	5	15	MFC560A
584 - 656	0 - 12	+5	<35	0	± 2	7 - 11	-102/-125	10	1	2	MFC584A
600 - 1200	0 - 20	+5	<35	+5	± 2	30 - 55	-97/-123	10	1	15	MFC-S-600
700 - 1400	0 - 25	+5	<35	+5	± 2	25 - 40	-100/-125	10	5	15	MFC-S-700
750 - 1450	0 - 14	+15	<35	+12	± 2	55 - 75	-95/-120	10	5	5	MFC750A
800 - 1600	0 - 20	+5	<35	+5	± 2	30 - 60	-100/-125	10	5	15	MFC-S-800
800 - 1600	0.5 - 21	+11.5	<40	+9	± 3	30 - 60	-95/-120	20	5	15	MFC800A
860 - 1240	0.5 - 8.5	+10	<35	+10	± 2	50 - 60	-98/-123	10	1	15	MFC860A
900 - 1650	0 - 12	+12	<45	+8	± 2	60 - 80	-95/-120	12	2	5	MFC900A
900 - 1800	0 - 20	+5	<35	+5	± 2	30 - 60	-95/-120	10	5	15	MFC-S-900
902 - 928	0 - 2.2	+3.3	<15	0	± 2	25 - 30	- 95/-120	10	2	10	MFC902A
925 - 1650	2 - 21	+11.5	<40	+8	± 3	35 - 80	-98/-123	6	1	10	MFC925A
925 - 1650	1 - 21	+5	<20	+6	± 2	40 - 80	-95/-120	6	1	10	MFC925B
925 - 960	0.5 - 4.5	+5	<25	+6	± 2	16 - 21	-100/-125	10	1.5	2	MFC925C
950 - 1175	1.5 - 7	+10	<35	+8	± 1	50 - 60	-100/-128	10	5	15	MFC950A
950 - 1650	1 - 10	+12	<45	+6	± 2	85 - 100	-85/-110	15	3	9	MFC950B
1000 - 1300	0 - 5	+5	<25	+10	+ 2	65 - 95	-97/-123	10	3	12	MFC1000A
1000 - 1357	1.5 - 10	+12	<40	+10	± 2	45 - 65	-95/-115	10	3.5	8	MFC1000B
1005 - 1650	1 - 15	+15	<50	+12	± 2	50 - 70	-94/-118	15	4	11	MFC1005A
1030 - 1130	0.5 - 5.5	+5	<35	+3	± 2	15 - 25	-93/-120	10	5	15	MFC1030A
1074 - 1442	0.8 - 7.4	+10	<20	+4.5	± 3	55 - 115	-95/-120	15	5	5	MFC1074A
1090 - 1290	1 - 5	+5	<25	+9	± 2	55 - 75	-95/-120	10	3	9	MFC1090A
1092 - 1152	1 - 4	+5	<35	+5	± 2	20 - 30	-93/-120	10	5	15	MFC1092A
1140 - 1340	1 - 11	+11	<50	+7	± 2	30 - 45	-93/-120	10	3.5	3	MFC1140B
1140 - 1610	0.5 - 8.5	+10	<35	+10	± 2	60 - 70	-90/-115	10	5	15	MFC1140A
1140 - 1610	0 - 8.5	+5	<20	+6	± 3	70 - 90	-92/-117	10	5	15	MFC1140C
1150 -1520	1 - 11	+12	<50	+11	± 2	55 - 75	-95/-115	10	2	10	MFC1150A
1200 - 1800	1 - 10	+10	<30	0	± 2	60 - 100	-85/-110	10	2	5	MFC1200A
1200 - 1800	0 - 14	+15	<35	+12	± 2	48 - 64	-92/-115	10	4	12	MFC1200B
1200 - 2300	0 - 25	+5	<35	+3.5	± 2.5	35 - 80	-90/-115	10	5	15	MFC1200C
1250 - 2500	0 - 28	+5	<30	+3	± 2	55 - 75	-90/-120	10	5	15	MFC1250A
1290 - 1450	0.5 - 4	+5	<35	+2	± 2	45 - 75	-93/-115	20	5	15	MFC1290A
1295 - 1705	1 - 10	+12	<40	+10	± 2	35 - 50	-95/-120	10	4	12	MFC1295A
1300 - 1500	0.5 - 5	+5	<35	+8	± 2	40 - 60	-90/-115	10	5	15	MFC1300B

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
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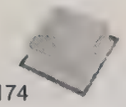
Miniature Surface-Mount Package



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FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
1300 - 2000	0 - 20	+8	<35	+9	± 2	35 - 55	-90/-115	10	5	15	**MFC1300A**
1310 - 1705	0.5 - 9.5	+12	<40	+10	± 2	48 - 65	-95/-115	10	4	12	**MFC1310A**
1350 - 2450	0.5 - 20	+5	<35	+4	± 3	60 - 100	-92/-116	10	5	15	**MFC1350A**
1355 - 1405	1 - 5	+5	<40	+5	± 2	15 - 22	-95/-117	15	4	10	**MFC1355A**
1400 - 2000	1 - 20	+8	<35	+7	± 3	35 - 47	-92/-115	10	5	15	**MFC1400B**
1400 - 2600	0 - 25	+8	<35	+7	± 2	55 - 75	-95/-120	12	5	15	**MFC1400A**
1420 - 2007	1 - 8	+10	<35	+6	± 2	85 - 110	-83/-108	10	2	15	**MFC1420A**
1420 - 1655	0.5 - 11	+8	<20	+10	± 2	28 - 40	-98/-118	10	3	10	**MFC1420B**
1423 - 1458	1 - 4	+5	<20	0	± 2	12 - 25	-97/-122	10	5	15	**MFC1423A**
1446 - 1880	0.8 - 7.4	+10	<20	+4.5	± 3	65 - 125	-92/-118	15	5	5	**MFC1446A**
1510 - 1651	1.5 - 8	+8	<15	+2.5	± 2.5	18 - 36	-96/-121	12	3	5	**MFC1510A**
1525 - 2350	1 - 13.5	+15	<35	+12	± 2.5	75 - 100	-90/-117	12	5	15	**MFC1525A**
1575 - 2575	0 - 20	+5	<35	+4	± 3	60 - 80	-90/-115	10	5	15	**MFC1575A**
1600 - 2000	1 - 10	+8	<35	+6	± 2	50 - 60	-95/-115	10	5	15	**MFC1600A**
1620 - 1740	0.5 - 4.5	+8	<35	+10.5	± 2.5	32 - 45	-95/-117	10	3	12	**MFC1620A**
1640 - 1900	1 - 10	+10	<35	+7	± 2	35 - 50	-90/-115	10	3	10	**MFC1640A**
1700 - 1850	2 - 10	+12	<30	+10	± 2	18 - 25	-96/-121	20	1	15	**MFC1700B**
1700 - 2500	0.5 - 7	+15	<35	+6.5	± 2	80 - 190	-90/-110	10	5	15	**MFC1700A**
1750 - 2500	1 - 12	+5	<35	+7.5	± 2.5	75 - 100	-90/-115	10	4	12	**MFC1750A**
1772 - 1913	1.5 - 8	+8	<15	+2.5	± 2.5	18 - 36	-97/-121	12	3	5	**MFC1772A**
1780 - 2980	0 - 22	+5	<30	+6	± 2	60 - 75	-90/-115	10	5	10	**MFC1780A**
1805 - 1880	0.5 - 4.5	+5	<25	+6	± 2	31 - 38	-95/-120	10	1.5	2	**MFC1805A**
1830 - 2200	2 - 10	+12	<40	+10	± 2	45 - 55	-97/-118	15	4	14	**MFC1830A**
1860 - 1960	0.5 - 5	+8	<35	+6	± 2	30 - 50	-97/-117	10	2	10	**MFC1860A**
1900 - 1960	0 - 5	+5	<35	+2	± 2	24 - 40	-95/-120	10	5	15	**MFC1900B**
1900 - 2400	1 - 8	+5	<35	+6	± 3	80 - 110	-85/-110	10	5	15	**MFC1900A**
1920 - 1980	0 - 5	+5	<20	+3	± 2	15 - 25	-90/-110	10	5	5	**MFC1920A**
1950 - 2265	1 - 20	+5	<40	+7	± 2	15 - 22	-95/-117	10	5	15	**MFC1950A**
2007 - 2595	1 - 8	+10	<35	+6.5	± 2	85 - 110	-85/-107	10	2	15	**MFC2007A**
2030 - 2330	0 - 5	+5	<35	+3	± 2	65 - 80	-90/-115	15	4	12	**MFC2030A**
2050 -2850	0 - 9	+5	<25	+2	± 2	100 - 120	-70/-95	10	8	30	**MFC2050A**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
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SYNERGY MICROWAVE CORPORATION

VOLTAGE CONTROLLED OSCILLATORS

MINIATURE SURFACE-MOUNT PACKAGE

174

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
2100 - 2400	1 - 14	+12	<35	+10	± 3.5	27 - 35	-101/-125	10	4	18	MFC2100A
2130 - 2204	0 - 5	+10	<35	+4	± 2	25 - 40	-85/-110	10	5	15	MFC2130A
2140 - 2200	0.5 - 5	+5	<35	0	± 3	22 - 30	-90/-112	10	5	15	MFC2140A
2160 - 2480	0 - 5.5	+3.3	<15	0	± 2	68 - 85	-88/-110	15	5	15	MFC2160A
2180 - 2240	0 - 5	+5	<35	+2	± 2	24 - 40	-95/-120	10	5	15	MFC2180A
2200 - 2400	0.5 - 4	+4	<30	+11	± 2.5	80 - 100	-87/-113	10	5	15	MFC2200A
2200 - 2800	0.5 - 17	+15	<35	+12	± 2	42 - 55	-90/-112	10	5	17	MFC2200B
2250 - 2400	2 - 12	+5	<35	+6	± 2	17 - 25	-97/-118	10	5	15	MFC2250A
2265 - 2750	1 - 22	+5	<40	+7	± 2	27 - 40	-95/-117	10	5	18	MFC2265A
2270 - 2540	2 - 15	+5	<35	+6	± 2	23 - 30	-100/-125	10	2	5	MFC2270A
2290 - 2590	1 - 11	+12	<30	+10	± 2	40 - 50	-100/-125	20	1	15	MFC2290A
2300 - 2500	2 - 10	+12	<30	+10	± 2	25 - 35	-100/-125	20	1	15	MFC2300A
2330 - 2550	1 - 11	+12	<35	+10	± 2	30 - 50	-95/-120	15	5	15	MFC2330A
2400 - 2500	0 - 5	+5	<20	+3.5	± 2.5	20 - 30	-95/-117	10	5	12	MFC2400A
2425 - 2825	1 - 13	+12	<35	+10	± 3	30 - 60	-92/-112	10	5	15	MFC2425A
2430 - 2480	0.5 - 5	+5	<35	0	± 3	18 - 28	-90/-112	10	5	15	MFC2430A
2470 - 2740	2 - 15	+5	<35	+6	± 2	23 - 30	-90/-115	10	5	15	MFC2470A
2500 - 2700	2 - 10	+12	<30	+10	± 2	25 - 35	-97/-119	15	1	15	MFC2500A
2500 - 2700	2 - 10	+5	<30	+10	± 2	30 - 40	-95/-120	15	1	15	MFC2500B
2520 - 2720	1 - 10	+11	<50	+7	± 2	36 - 44	-90/-115	10	3.5	3	MFC2520A
2560 - 2800	0.5 - 8	+5	<35	+9	± 2	35 - 50	-92/-117	10	5	15	MFC2560A
2700 - 3100	1 - 12	+5	<35	+7	± 2	40 - 55	-90/-110	10	5	15	MFC2700A
2750 - 2860	0.5 - 9	+5	<35	+8	± 2	15 - 25	-93/-115	10	5	15	MFC2750A
2900 - 3100	1 - 10	+10	<30	+7	± 2	25 - 55	-80/-105	20	10	20	MFC2900A
3200 - 3320	0 - 5	+5	<35	+2	± 2	35 - 50	-85/-110	10	5	15	MFC3200A
3300 - 3400	0.5 - 10	+10	<35	+10	± 2	20 - 30	-90/-115	10	5	15	MFC3300A
4650 - 5350	1 - 14	+15	<20	+5	± 2	100 - 130	-80/-100	10	10	20	MFC4650A
5350 - 5750	1 - 4	+10	<45	+9.5	±3	170 - 230	-70/-97	10	8	35	MFC5350A
5400 -5900	1 - 14	+15	<20	+5	± 2	100 - 130	-80/-100	10	10	20	MFC5400A
5900 - 6100	3 - 8	+10	<20	+5	± 3	130	-70/-97	10	10	20	MFC5900A

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

SYNERGY MICROWAVE CORPORATION
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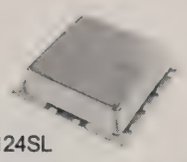
VOLTAGE CONTROLLED OSCILLATORS



124SL

SURFACE-MOUNT PACKAGE

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
170 - 220	0 - 10	+7	<13	+3	±3	5 - 10	-95/-115	10	5	15	VCO-S-A12
180 - 220	0 - 5	+7	<35	0	±1	9 - 14	-95/-115	10	5	15	VCO-S-A17
200 - 400	0 - 17	+12	<35	+14	±2.5	10 - 20	-90/-115	10	5	15	VCO-S-200
210 - 270	1 - 12	+12	<35	+10	±3	5 - 6	-94/-118	10	5	15	VCO210SA
225 - 450	1 - 17	+7	<13	+4	±2.5	20 - 30	-95/-115	9	5	15	VCO225SA
250 - 500	2 - 22	+12	<35	+14	±2.5	10 - 20	-95/-120	10	5	15	VCO-S-250
350 - 410	2 - 10	+8	<35	+7	±2	7.5 - 15	-100/-125	10	1	15	VCO-S-A23
400 - 450	2 - 10	+8	<35	+7	±2	6.0 - 15	-98/-120	10	1	15	VCO-S-A22
400 - 650	0.5 - 5	+5	<20	+7	±3.5	50 - 80	-95/-120	10	5	15	VCO400SA
400 - 800	0.5 - 15	+12	<35	+15	±2.5	20 - 30	-95/-120	10	1	15	VCO-S-400
470 - 650	1 - 11	+12	<35	+12	±2.5	20 - 30	-97/-112	10	1	15	VCO470SA
500 - 1000	0.5 - 30	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	VCO-S-500
500 - 600	0 - 5	+7	<35	0	±1	20 - 30	-90/-115	10	5	15	VCO-S-A18
550 - 890	1 - 18	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	VCO550SA
600 - 1200	0.5 - 25	+12	<35	+12	±2.5	25 - 45	-95/-120	10	1	15	VCO-S-600
700 - 1400	0.5 - 25	+12	<35	+15	±3	35 - 60	-95/-120	10	5	15	VCO-S-700
750 - 830	1 - 4	+12	<30	+14.5	±1.5	35 - 45	-90/-117	10	5	15	VCO-S-A06
800 - 1600	0 - 25	+12	<35	+14	±3.5	40 - 60	-95/-120	10	1	15	VCO-S-800
844 - 919	1 - 4	+12	<35	+14	±1.5	25 - 40	-85/-110	18	2	4.5	VCO844SA
900 - 1800	0.5 - 20	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	VCO-S-900
900 - 2200	0 - 25	+12	<35	+12	±2.5	55 - 80	-85/-110	10	8	15	VCO900SA
950 - 1175	4 - 15	+12	<35	+13	±3	21 - 27	-95/-118	10	1	15	VCO-S-A27
1000 - 2000	0.5 - 22	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	VCO-S-1000
1000 - 2000	0.5 - 22	+12	<35	+6	±2.5	50 - 70	-98/-126	10	5	15	VCO1000SA
1100 - 2200	0.5 - 25	+12	<35	+13	±3	40 - 60	-95/-120	10	5	15	VCO-S-1100
1200 - 2400	0 - 26	+5	<35	+10	±3	40 - 100	-90/-115	10	5	15	VCO 1200SA
1500 - 2100	1 - 12	+12	<35	+10	±3	40 - 60	-88/-115	10	5	15	VCO1500SA
1600 - 2000	0 - 5	+5	<35	+10	±3	80 - 100	-90/-115	10	13	10	VCO1600SA
1600 - 2600	0 - 26	+5	<35	+10	±3	40 - 60	-90/-120	10	5	15	VCO-S-A24
1750 - 2000	1 - 9	+9.6	<30	+10	±3	35 - 60	-82/-110	10	8	30	VCO1750SA
2000 - 3000	0 - 25	+12	<35	+9	±2	40 - 70	-88/-116	10	8	15	VCO-S-2000

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

RF OUT	V_{cc}	V_{tune}	CASE GND
1	4	16	ALL OTHERS

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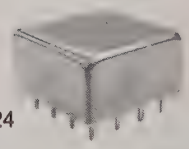
SYNERGY MICROWAVE CORPORATION

VOLTAGE CONTROLLED OSCILLATORS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PLUG-IN PACKAGE

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
170 - 220	0 - 10	+7	<13	+3	±3	5 - 10	-95/-115	10	5	15	**VCO-P-A12**
180 - 220	0 - 5	+7	<35	0	±1	9 - 14	-95/-115	10	5	15	**VCO-P-A17**
200 - 400	0 - 17	+12	<35	+14	±2.5	10 - 20	-90/-115	10	5	15	**VCO-P-200**
210 - 270	1 - 12	+12	<35	+10	±3	5 - 6	-94/-118	10	5	15	**VCO210PA**
225 - 450	1 - 17	+7	<13	+4	±2.5	20 - 30	-95/-115	9	5	15	**VCO225PA**
250 - 500	2 - 22	+12	<35	+14	±2.5	10 - 20	-95/-120	10	5	15	**VCO-P-250**
350 - 410	2 - 10	+8	<35	+7	±2	7.5 - 15	-100/-125	10	1	15	**VCO-P-A23**
400 - 450	2 - 10	+8	<35	+7	±2	6.0 - 15	-98/-120	10	1	15	**VCO-P-A22**
400 - 650	0.5 - 5	+5	<20	+7	±3.5	50 - 80	-95/-120	10	5	15	**VCO400PA**
400 - 800	0.5 - 15	+12	<35	+15	±2.5	20 - 30	-95/-120	10	1	15	**VCO-P-400**
470 - 650	1 - 11	+12	<35	+12	±2.5	20 - 30	-97/-112	10	1	15	**VCO470PA**
500 - 600	0 - 5	+7	<35	0	±1	20 - 30	-90/-115	10	5	15	**VCO-P-A18**
500 - 1000	0.5 - 30	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	**VCO-P-500**
550 - 890	1 - 18	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	**VCO550PA**
600 - 1200	0.5 - 25	+12	<35	+12	±2.5	25 - 45	-95/-120	10	1	15	**VCO-P-600**
700 - 1400	0.5 - 25	+12	<35	+15	±3	35 - 60	-95/-120	10	5	15	**VCO-P-700**
750 - 830	1 - 4	+12	<30	+14.5	±1.5	35 - 45	-90/-117	10	5	15	**VCO-P-A06**
800 - 1600	0 - 25	+12	<35	+14	±3.5	40 - 60	-95/-120	10	1	15	**VCO-P- 800**
844 - 919	1 - 4	+12	<35	+14	±1.5	25 - 40	-85/-110	18	2	4.5	**VCO844PA**
900 - 1800	0.5 - 20	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	**VCO-P- 900**
900 - 2200	0 - 25	+12	<35	+12	±2.5	55 - 80	-85/-110	10	8	15	**VCO900PA**
950 - 1175	4 - 15	+12	<35	+13	±3	21 - 27	-95/-118	10	1	15	**VCO-P-A27**
1000 - 2000	0.5 - 22	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	**VCO-P-1000**
1000 - 2000	0.5 - 22	+12	<35	+6	±2.5	50 - 70	-98/-126	10	5	15	**VCO1000PA**
1100 - 2200	0.5 - 22	+12	<35	+13	±3	40 - 60	-95/-120	10	5	15	**VCO- P-1100**
1200 - 2400	0 - 26	+5	<35	+10	±3	40 - 100	-90/-115	10	5	15	**VCO 1200PA**
1500 - 2100	1 - 12	+12	<35	+10	±3	40 - 60	-88/-115	10	5	15	**VCO1500PA**
1600 - 2000	0 - 5	+5	<35	+10	±3	80 - 100	-90/-115	10	13	10	**VCO1600PA**
1600 - 2600	0 - 26	+5	<35	+10	±3	40 - 60	-90/-120	10	5	15	**VCO-P-A24**
1750 - 2000	1 - 9	+9.6	<30	+10	±3	35 - 60	-82/-110	10	8	30	**VCO1750PA**
2000 - 3000	0 - 25	+12	<35	+9	±2.0	40 - 70	-88/-116	10	8	15	**VCO-P-2000**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

RF OUT	V_{cc}	V_{tune}	CASE GND
1	4	16	ALL OTHERS

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SYNERGY® MICROWAVE CORPORATION

VOLTAGE CONTROLLED OSCILLATORS

165S

SURFACE-MOUNT PACKAGE

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
180 - 260	0 - 10	+12	<30	+7.5	±2	8 - 15	-95/-120	10	1	15	**VFC180SA**
200 - 400	0 - 17	+12	<35	+14	±2.5	10 - 20	-90/-115	10	5	15	**VFC-S-200**
210 - 270	1 - 12	+5.0	<35	0	±2	5 - 6	-90/-115	10	5	15	**VFC210SA**
219 - 256	1 - 4.5	+5	<20	0	±2	12 - 20	-105/-127	10	5	5	**VFC219SA**
250 - 500	0 - 22	+12	<35	+12	±2.5	10 - 20	-95/-115	10	5	15	**VFC-S-250**
400 - 800	0 - 15	+12	<35	+12	±2.5	20 - 30	-95/-120	10	5	15	**VFC-S-400**
425 - 500	1 - 12	+12	<35	+10	±3	5 - 10	-95/-120	10	5	15	**VFC-S-A05**
490 - 560	0 - 4.5	+8	<20	0	±2	17 - 25	-100/-125	10	1	2	**VFC490SA**
500 - 1000	0.5 - 25	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	**VFC-S-500**
600 - 1200	0.5 - 25	+12	<35	+15	±3	25 - 45	-95/-120	10	1	15	**VFC-S-600**
700 - 1400	0.5 - 25	+12	<35	+15	±3	35 - 60	-95/-120	10	1	15	**VFC-S-700**
800 - 1600	0 - 25	+12	<35	+14	±3.5	40 - 60	-95/-120	10	5	15	**VFC-S-800**
900 - 1800	0.5 - 20	+12	<35	+13	±3	40 - 60	-95/-120	10	5	15	**VFC-S-900**
900 - 1735	0 - 18	+15	<45	+13	±1.5	40 - 60	-95/-120	10	5	16	**VFC900SA**
900 - 1200	2.5 - 10.5	+12	<35	+6	±1.5	40 - 60	-95/-120	10	5	15	**VFC900SB**
920 - 1455	0 - 12	+12	<35	+13	±3	45 - 60	-95/-120	10	5	15	**VFC920SA**
936 - 1636	0 - 20	+12	<35	+10	±3	20 - 50	-90/-115	10	5	15	**VFC 936SA**
1000 - 2000	0.5 - 22	+12	<35	+13	±3	40 - 60	-95/-120	10	5	15	**VFC-S-1000**
1200 - 1600	2.5 - 11	+12	<35	+6	±1.5	50 - 70	-95/-120	10	5	15	**VFC1200SA**
1225 - 2375	0 - 25	+11	<35	+12	±4	50 - 70	-95/-120	10	2	30	**VFC1225SA**
1300 - 2300	0 - 24	+15	<40	+12	±3	40 - 60	-90/-110	10	1	15	**VFC1300SA**
1305 - 1512	2 - 10	+12	<30	+10	±1	20 - 40	-95/-120	20	5	15	**VFC-S-A07**
1355 - 1595	2 - 10	+12	<30	+10	±1	25 - 45	-95/-115	10	1	15	**VFC-S-A06**
1500 - 2100	1 - 12	+12	<35	+10	±3	40 - 60	-92/-117	10	5	15	**VFC-S-A02**
1850 - 1950	0.5 - 6.5	+8	<40	+8	±2	20 - 30	-95/-122	12	3.5	15	**VFC1850SA**
2300 - 2450	0.5 - 7	+8	<35	+8	±2	25 - 35	-95/-120	12	3.5	20	**VFC2300SA**
2355 - 2528	0.5 - 4.5	+12	<35	+5	±3	50 - 60	-90/-115	10	5	10	**VFC2355SA**
2530 - 2730	1 - 9	+12	<35	+10	±2	30 - 45	-90/-120	20	5	15	**VFC2530SA**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

VOLTAGE CONTROLLED OSCILLATORS

PLUG-IN PACKAGE

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
200 - 400	0 - 17	+12	<35	+14	±2.5	10 - 20	-90/-115	10	5	15	VFC-P-200
250 - 500	0 - 22	+12	<35	+12	±2.5	10 - 20	-95/-115	10	5	15	VFC-P-250
400 - 800	0.5 - 15	+12	<35	+15	±2.5	20 - 30	-95/-120	10	1	15	VFC-P-400
500 - 1000	0.5 - 25	+12	<35	+14	±2.5	25 - 50	-95/-120	10	1	15	VFC-P-500
600 - 1200	0.5 - 25	+12	<35	+15	±3	25 - 45	-95/-120	10	1	15	VFC-P-600
700 - 1400	0.5 - 25	+12	<35	+15	±3	35 - 60	-95/-120	10	1	15	VFC-P-700
800 - 1600	0 - 25	+5	<35	+10	±3	40 - 60	-95/-120	10	1	15	VFC-P-800
900 - 1800	0.5 - 20	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	VFC-P-900
1000 - 2000	0.5 - 22	+12	<35	+11	±3	40 - 60	-95/-120	10	5	15	VFC-P-1000
1630 - 1930	2 - 22	+10	<50	+10	±2	15 - 30	-95/-115	10	5	15	VFC-P-A02

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -30°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

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VOLTAGE CONTROLLED OSCILLATORS

Ceramic Coaxial Resonator
Miniature Surface-Mount Package

174

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
740 - 810	2 - 10	+8	<35	+5	±2	9 - 12	-107/-130	10	1	5	**MFO740A**
751 - 777	2 - 9	+8.5	<20	+5	±2	3.5 - 5.5	-110/-140	20	2	5	**MFO751A**
762 - 795	2 - 9	+8	<35	+5	±2	5 - 8	-105/-130	16	2	5	**MFO762A**
770 - 780	0.5 - 8.5	+10	<35	-3	±1	1.3 - 3	-110/-135	10	1	15	**MFO770A**
788 - 815	2 - 9	+8	<35	+6	±3	3.9 - 7	-105/-130	18	2	5	**MFO788A**
816 - 846	0.5 - 3	+10	<20	0	±2	12 - 15	-100/-125	15	2	5	**MFO816A**
837 - 848	0.75 - 4.25	+5	<25	0	±3	3 - 5	-106/-126	10	1.5	2	**MFO837A**
837 - 863	0.75 - 4.25	+5	<20	0	±2.5	7 - 10	-106/-125	10	1.5	3	**MFO837B**
925 - 960	1 - 8	+8	<40	+3	±3	6 - 10	-106/-130	15	2	1	**MFO925A**
935 - 945	1 - 5	+8	<40	+3	±2	6 - 9	-102/-122	10	2	5	**MFO935A**
945 - 985	1 - 4.5	+12	<35	+7	±2	14 - 20	-100/-125	10	0.5	1	**MFO945A**
1079 - 1114	1 - 8	+8	<40	+5	±3	6 - 10	-105/-130	15	2	1	**MFO1079A**
1290 - 1310	2 - 24	+5	<35	0	±2	2 - 4	-105/-135	10	1	1	**MFO1290A**
1320 - 1330	1 - 8	+12	<35	+10	±2	2 - 4	-108/-135	10	2	1	**MFO1320A**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

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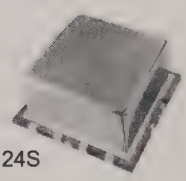
CERAMIC COAXIAL RESONATOR SURFACE-MOUNT PACKAGE



124S

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
617 - 627	1 - 5	+4.5	<40	0	±1.5	2 - 4	-110/-135	10	1	15	**CRO617SA**
681 - 716	1 - 8	+8	<40	+11	±1.5	5 - 6	-120/-145	10	1	5	**CRO-S-698**
700 - 730	1 - 8	+9	<26	0	±2.5	3.5 - 5.5	-118/-140	10	1	15	**CRO700SA**
702 - 738	1 - 8	+8	<40	+11	±1.5	5 - 7	-111/-137	10	1	5	**CRO702SA**
727 - 767	1 - 8	+9	<20	0	±2.5	4 - 6	-108/-132	10	1	5	**CRO-S-747**
750 - 850	1 - 24	+12	<40	+10	±2.5	4 - 6	-105/-130	10	5	15	**CRO750SA**
869 - 894	1.5 - 5	+12	<40	+6.5	±2.5	7 - 10	-110/-135	10	1	5	**CRO-S-A04**
889 - 970	1 - 11	+12	<35	+5	±2	8 - 30	-115/-140	10	1	15	**CRO889SA**
902 - 928	1 - 4	+5	<40	0	±2.5	5.5 - 7.5	-105/-130	10	1	5	**CRO-S-915**
917 - 950	1.5 - 5	+12	<40	0	±2.5	11 - 18	-105/-130	10	1	15	**CRO917SA**
923 - 962	1.5 - 6.5	+8	<25	+3	±3	8 - 14	-100/-130	15	5	15	**CRO923SA**
935 - 960	1.5 - 5	+12	<40	0	±2.5	8 - 14	-105/-130	10	1	15	**CRO935SA**
960 - 990	1 - 8	+5	<40	0	±2.5	4 - 6	-105/-130	10	2	5	**CRO-S-975**
1020 - 1070	1 - 10	+8	<40	+4	±2.5	5.5 - 8.0	-105/-125	10	2	5	**CRO-S-A03**
1020 - 1040	1 - 8	+12	<40	+8	±2.5	4 - 6	-105/-132	10	1	15	**CRO-S-1030**
1030 - 1050	1 - 4	+12	<35	+12	±1.5	7 - 10	-95/-130	10	1	15	**CRO-S-1040**
1055 - 1125	1 - 10	+12	<40	+10	±2	7 - 10	-105/-130	10	1	15	**CRO1055SA**
1079 - 1114	1 - 8	+8	<40	+5	±3	6 - 10	-115/-138	15	5	15	**CRO1079SA**
1160 - 1180	1 - 8	+12	<35	+7	±2	7 - 9	-100/-130	15	2	5	**CRO1170SA**
1175 - 1245	1 - 10	+12	<40	+10	±2	7 - 10	-115/-138	10	1	15	**CRO1175SA**
1315 - 1335	1 - 8	+5	<18	0	±2	4 - 6	-100/-130	10	1	15	**CRO-S-1325**
1511 - 1586	1 - 9	+8	<40	+4	±2	10 - 18	-106/-131	10	1	1	**CRO-S-1548**
1594 - 1669	1 - 8	+8	<25	+3	±3	11 - 17	-100/-130	15	5	15	**CRO1594SA**
1600 - 1630	1 - 4	+6	<40	0	±2.5	10 - 14	-100/-125	10	1	5	**CRO-S-A05**
1710 - 1770	2 - 10	+15	<40	+6	±3	8 - 12	-105/-135	10	1	15	**CRO1710SA**
1778 - 1842	0.5 - 4.5	+12	<40	+2	±2.5	18 - 25	-102/-128	10	1	5	**CRO1778SA**
1785 - 1842	2 - 10	+12	<40	+6	±3	8 - 12	-105/-130	10	1	15	**CRO-S-A06**
1855 - 1910	2 - 10	+12	<40	+6	±3	8 - 12	-105/-130	10	1	15	**CRO1855SA**
1890 - 1950	1 - 10	+8	<40	+10	±2.5	7 - 9	-88/-120	10	1	5	**CRO-S-1920**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

RF OUT	V_{cc}	V_{tune}	CASE GND
1	4	16	ALL OTHERS

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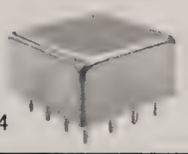
CERAMIC COAXIAL RESONATOR PLUG-IN PACKAGE



124

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
617 - 627	1 - 5	+4.5	<40	0	±1.5	2 - 4	-110/-135	10	1	15	**CRO617PA**
681 - 716	1 - 8	+8	<40	+11	±1.5	4 - 6	-120/-145	10	1	5	**CRO-P-698**
700 - 730	1 - 8	+9	<26	0	±2.5	3.5 - 5.5	-118/-140	10	1	15	**CRO700PA**
702 - 738	1 - 8	+8	<40	+11	±1.5	5 - 7	-110/-135	10	2	5	**CRO702PA**
727 - 767	1 - 8	+9	<20	0	±2.5	4 - 6	-108/-132	10	1	5.0	**CRO-P-747**
750 - 850	1 - 24	+12	<40	+10	±2.5	4 - 6	-105/-130	10	5	15	**CRO750PA**
889 - 970	1 - 11	+12	<35	+5	±2	8 - 30	-115/-140	10	1	15	**CRO889PA**
902 - 928	1 - 4	+5	<40	0	±2.5	5.5 - 7.5	-105/-130	10	1	5	**CRO-P-915**
917 - 950	1.5 - 5	+12	<40	0	±2.5	11 - 18	-105/-130	10	1	15	**CRO917PA**
923 - 962	1.5 - 6.5	+8	<25	+3	±3	8 - 14	-100/-130	15	5	15	**CRO923PA**
935 - 960	1.5 - 5	+12	<40	0	±2.5	8 - 14	-105/-130	10	1	15	**CRO935PA**
960 - 990	1 - 8	+5	<40	0	±2.5	4 - 6	-105/-130	10	2	5	**CRO-P-975**
1020 - 1040	1 - 8	+12	<40	+8	±2.5	4 - 6	-105/-132	10	1	15	**CRO-P-1030**
1030 - 1050	1 - 4	+12	<35	+12	±1.5	7 - 10	-95/-130	10	1	15	**CRO-P-1040**
1055 - 1125	1 - 10	+12	<40	+10	±2	7 - 10	-105/-130	10	1	15	**CRO1055PA**
1079 - 1114	1 - 8	+8	<40	+5	±3	6 - 10	-115/-138	15	5	15	**CRO1079PA**
1160 - 1180	1 - 8	+12	<35	+7	±2	7 - 9	-100/-130	15	2	5	**CRO1170PA**
1175 - 1245	1 - 10	+12	<40	+10	±2	7 - 10	-115/-138	10	1	15	**CRO1175PA**
1315 - 1335	1 - 8	+5	<18	0	±2	4 - 6	-100/-130	10	1	15	**CRO-P-1325**
1511 - 1586	1 - 9	+8	<40	+4	±2	10 - 18	-106/-131	10	1	1	**CRO-P-1548**
1594 - 1669	1 - 8	+8	<25	+3	±3	11 - 17	-100/-130	15	5	15	**CRO1594PA**
1710 - 1770	2 - 10	+15	<40	+6	±3	8 - 12	-105/-135	10	1	15	**CRO1710PA**
1778 - 1842	0.5 - 4.5	+12	<40	+2	±2.5	18 - 25	-102/-128	10	1	5	**CRO1778PA**
1890 - 1950	1 - 10	+12	<40	+10	±2.5	7 - 9	-88/-120	10	1	5	**CRO-P-1920**

COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

RF OUT	V_{cc}	V_{tune}	CASE GND
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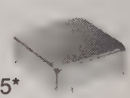
VOLTAGE CONTROLLED OSCILLATORS

Ceramic Coaxial Resonator Surface-Mount Package

165S*

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
284 - 319	2 - 12	+12	<40	+6	±2	4 - 10	-125/-150	10	2	2	**CFO284SA**
681 - 716	1 - 8	+8	<40	+4	±2	4 - 6	-117/-142	10	1	5	**CFO-S-698**
1079 - 1114	1 - 9	+8	<40	+5	±3	6 - 10	-105/-130	15	1	5	**CFO1079SA**
1719 - 1791	1 - 8	+8	<40	+6	±3	10 - 14	-105/-130	10	2	5	**CFO1719SA**
1785 - 1842	2 - 10	+12	<40	+6	±3	8 - 12	-105/-130	10	2	5	**CFO1785SA**
2300 - 2320	1 - 10	+10	<40	+6	±2	8 - 12	-110/-135	12	2	5	**CFO2300SA**

Ceramic Coaxial Resonator Through-Hole Package



165*

FREQUENCY RANGE (MHz)	NOMINAL TUNING VOLTAGE (Volts)	DC BIAS REQUIREMENTS VOLTAGE (Volts)	DC BIAS REQUIREMENTS CURRENT (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	AVERAGE TUNING SENSITIVITY MHz/Volt	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION (dBc)	PUSHING (MHz/Volt) (Typ)	PULLING (@ 1.75:1 VSWR) MHz (Typ)	MODEL
681 - 716	1 - 8	+8	<40	+4	±2	4 - 6	-117/-142	10	1	5	**CFO-P-698**
1719 - 1791	1 - 8	+8	<40	+6	±3	10 - 14	-105/-130	10	2	5	**CFO1719PA**
1785 - 1842	2 - 10	+12	<40	+6	±3	8 - 12	-105/-130	10	2	5	**CFO1785PA**

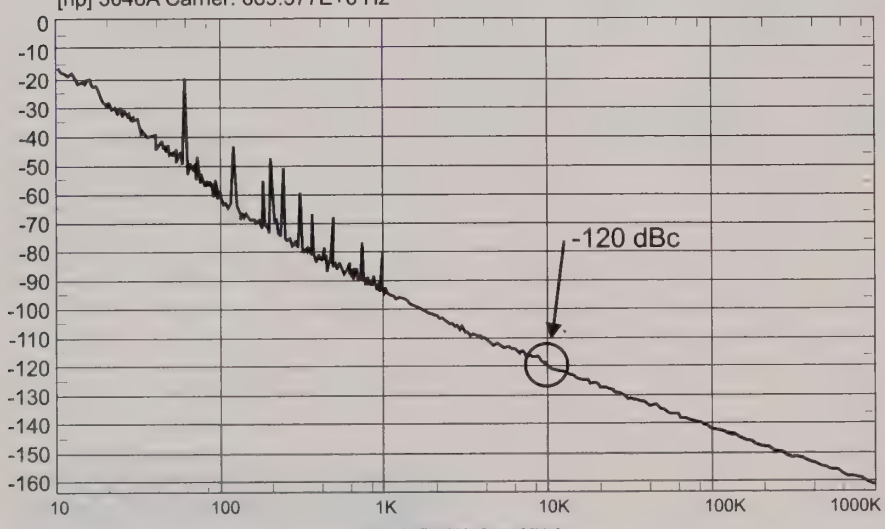
COMMON SPECIFICATIONS

Output Impedance: 50 ohms
VSWR: 1.5:1 (Typ)
Modulation Bandwidth: 2.5 MHz (Typ)

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range
Specifications are at +25°C

For pin location and package outline drawings, see back pages.
*0.440 inches, maximum cover height

681 to 716 resonator vco with discriminator technique
[hp] 3048A Carrier: 689.377E+6 Hz



ℒ (f) [dBc / Hz] vs f [Hz]

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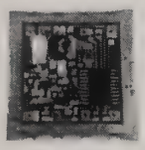
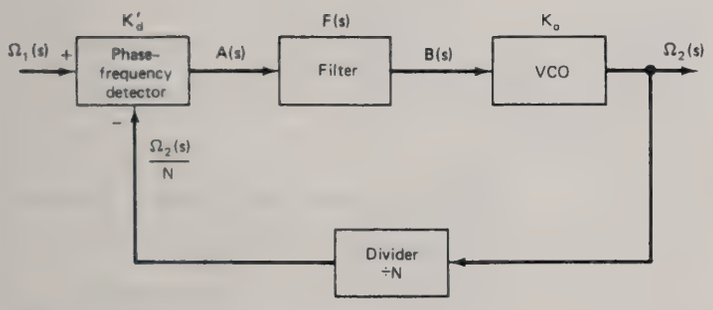
Voltage controlled oscillators are used as an important part of frequency synthesizers. A frequency synthesizer is a unit that stabilizes the frequency of a free-running oscillator against a stable reference, typically a crystal oscillator. Depending on the reference frequency at the phase detector and the resulting division ratio, the output frequency within the loop bandwidth reflects the properties of the reference. This means that if the division ratio is small and the reference frequency comes from an ultrastable crystal oscillator, the quality of the "locked" VCO frequency is also extremely good. Given a particular phase noise of the crystal oscillator, its performance at the phase-detector level gets multiplied up to the output frequency of the VCO by 20 dB per decade. This means that the phase noise of a 1000-MHz VCO is 20 dB or 10 times noisier than a reference crystal oscillator at 10 MHz at the phase detector. This statement is valid only within the loop bandwidth; outside the loop bandwidth, the properties of the oscillator itself dominate. A vivid example is the application of a ceramic-resonator-based oscillator, which, free-running, exhibits phase noise of -125 dBc/Hz at 10 kHz from the carrier and -153 dBc/Hz at 800 kHz from the carrier, but which, phase-locked, exhibits a phase-noise level determined by noise within the loop bandwidth of 1 kHz.

Figure 1 shows the block diagram of a digital PLL. The reason why it is referred to as "digital" is because the divider is a digital implementation and the phase frequency detector also uses a digital rather than an analog, IC. Analog phase detectors would be double-balanced mixers; a typical digital phase detector is an exclusive OR gate. Given a particular VCO and an integrated circuit as a synthesizer chip, the designer must calculate the values of the loop filter. There are several types of loop filters, and the one with the best performance typically is the type 2, third order. It consists of an active integrator based on an operational amplifier that must exhibit excellent low-noise performance.





Note: The frequency transfer const. of the VCO = K_o (not $\frac{K_o}{s}$, which is valid for phase transfer only.)

Fig. 1 — Block diagram of a digital PLL before lock is acquired.

Figure 2 shows a loop filter for a type 2 third-order loop. This loop includes *two* integrators: the VCO, and the operational amplifier and its three associated time constants.

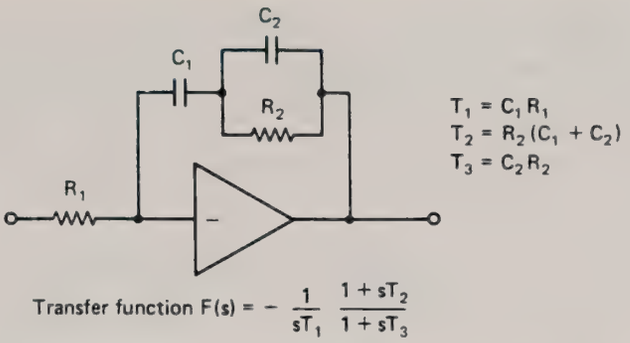


Fig. 2 — Circuit diagram of the loop filter for the third-order loop

This filter can be redrawn as shown in Figure 3. The transfer function for this filter

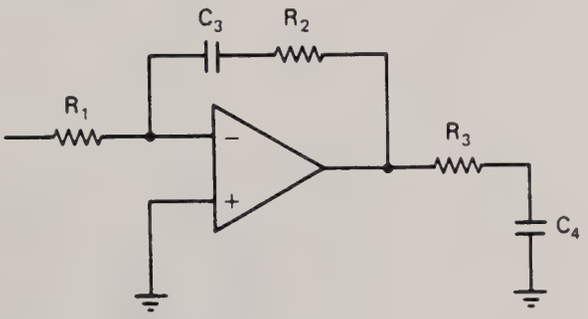
with

$$F(s) = \frac{-1}{s\tau_1}\frac{1+s\tau_2}{1+s\tau_3} \tag{1}$$

$$\tau_1 = C_1 R_1 \tag{2}$$

$$\tau_2 = R_2(C_1 + C_2) \tag{3}$$

$$\tau_3 = C_2 R_2 \tag{4}$$



$$F(s) = -\frac{1}{C_3 R_1}\frac{1+s/\omega_z'}{s(1+s/\omega_p)} \qquad \omega_z = \frac{1}{R_2 C_3} \qquad j\omega_p = \frac{1}{R_3 C_4}$$

Fig. 3 — Circuit diagram of redrawn Figure 2. Note that this is the same type of loop filter as in the type 2 second-order loop with an additional *RC* time constant.

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The actual design is best done with the computer program. A more complex filter as an application is shown in Figure 4.

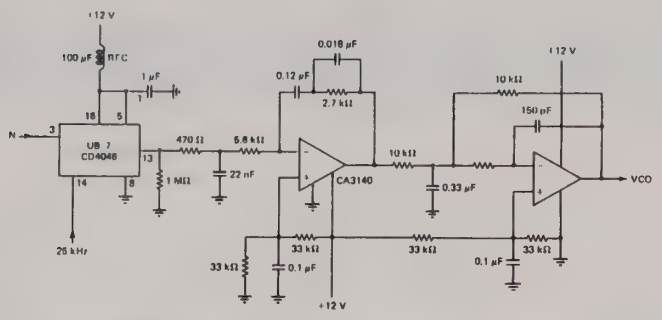


Fig. 4 — Phase/frequency comparator and loop for the 72 to 92 MHz frequency synthesizer.

A detailed overview on how to design a synthesizer is found in the book, *Microwave and Wireless Synthesizers: Theory and Design,* by Ulrich L. Rohde, to be published in August, 1997, by John Wiley & Sons, New York, NY, ISBN: 0471-52019-5.

Design pitfalls can cause noisy oscillator output. The typical positive three-terminal regulator is based on an NPN emitter follower, and therefore drives its load from a very low impedance. These devices have been known to burst into oscillation when driving capacitive loads. Installing RF choke (<1 µH) between the output pin and any bypass capacitors may prevent these spurious oscillations. Regulator circuits are now available with PNP-based, collector-driven output (Figure 5); these produce only a fraction of the output noise produced by standard NPN-emitter-follower types. Although they involve a slightly higher parts count than their emitter-follower equivalents, their better performance justifies the additional investment.

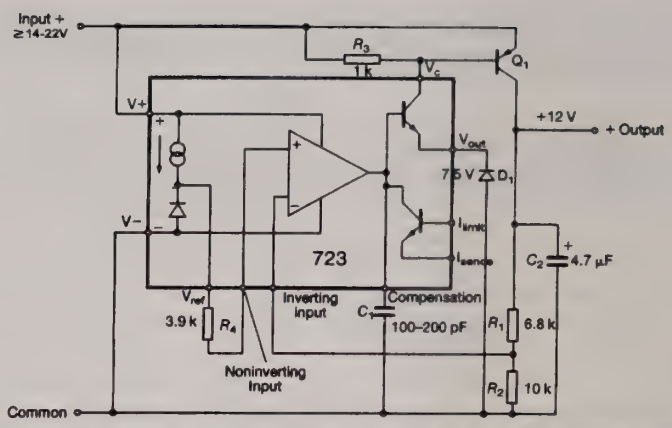


Fig. 5 - Schematic diagram of a 723-based regulator with extremely low output noise and low input-output voltage differential (0.5V). Its excellent noise performance is due to the fact that the PNP pass transistor Q1 acts as a current source and therefore produces much less noise for a given value of C_2.

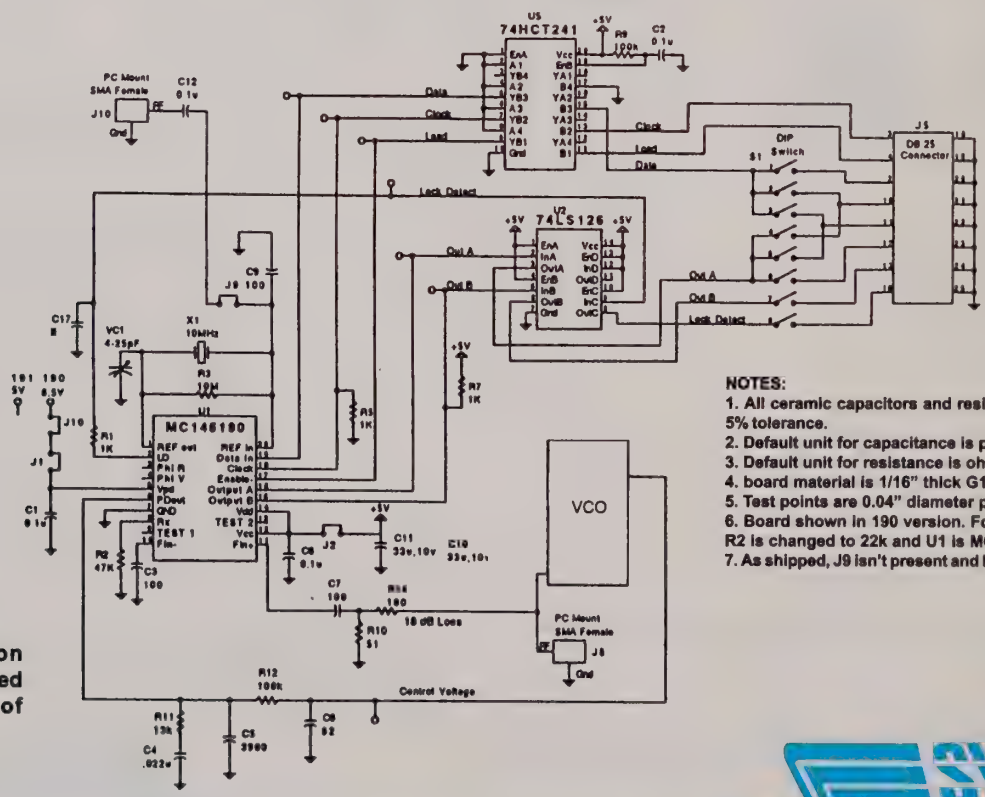
Typical performance:

Regulated output voltage is 12V
Line Regulation (12.5V ≤ V_{input} ≤15V) 3mV
Load Regulation (ΔI_{output} = 1A) 5mV

$$V_{OUT} = \frac{R_1 + R_2}{R_2} V_{ref} = 12\ \text{V}$$

As far as the best application of VCOs and synthesizer chips is concerned, the factory engineers are happy to work with their customers to optimize the design. Further details are found in the previously mentioned book, *Microwave and Wireless Synthesizers: Theory and Design,* by Ulrich L. Rohde.

Finally, for those interested in building a complete synthesizer using Synergy VCOs, Figure 6 shows an evaluation circuit proposed by Motorola.



NOTES:
1. All ceramic capacitors are 1206 surface mount, 5% tolerance.
2. Default unit for capacitance is pF.
3. Default unit for resistance is ohms.
4. board material is 1/16" thick G10.
5. Test points are 0.04" diameter plated through holes.
6. Board shown in 190 version. For 191, J10 is connected to 5V. R2 is changed to 22k and U1 is MC145191.
7. As shipped, J9 isn't present and board operates in crystal mode.

Fig. 6 — Evaluation circuit for phase locked loop (courtesy of Motorola).

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DEFINITION OF TERMS

Output Power - The output power of a synthesizer, typically expressed in dBm, is measured into a 50 ohm load. The output power varies with frequency and temperature, and is always combined with the specification for output power tolerance.

Step Size - The step size frequency in conventional PLL circuits is the same as the reference comparison frequency at the phase detector. It also signifies the change of the output frequency for a step increment or decrement step. In most applications, the step size is dictated by the channel spacing of the radio system.

Settling Time - The maximum amount of time required for the output frequency to reach a stable state. The reference and output frequencies reach frequency and phase lock conditions. The major factors that affect settling time are register VCO tuning speed, register loading time, loop filter bandwidth and loop filter order.

Spurious Reference Frequency Sideband - Spurious signals that result from unwanted FM modulation in the control lines. The most likely cause is phase detector pulse components that leak through the loop filter.

Non-Harmonic Spurious - Spurious sidebands appearing at the output not related to the reference frequency. Modulating signals of any kind at the VCO control line will cause spurious sidebands at the output. Non-Harmonic Sideband spurs usually result from noisy power supply/data lines. Proper AC bypassing and supply decoupling are critical for rejecting non-harmonic sideband spurious. Additionally, good grounding techniques must be exercised.

Harmonic Output Power - The harmonic content is measured relative to the output power. Typical harmonic suppression is 10 to 20 dB. In narrow band applications, this parameter can be improved.

Phase Noise - affects the system performance in such areas as multiple signal selectivity and signal to noise ratio. The phase noise inside the loop bandwidth is of a synthesizer is mainly controlled by the quality of the reference input signal source, loop filter, step size, and noise of the associated circuitry, including the phase detector noise floor. The VCO noise outside the loop is unaffected by the loop parameters.

Power Supply Requirements - The VCC1 and VCC2 power supply lines should be well isolated from each other to minimize interference to the VCO control line. The power supply voltage should not change by more than +/-2.5% from the specified specification for proper operation.

INTEGRATED FREQUENCY SYNTHESIZERS

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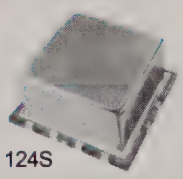
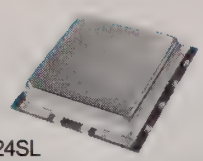

124S


124SL

197

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FREQUENCY RANGE (MHz)	STEP SIZE (KHz)	DC BIAS REQUIREMENTS Vcc1 & 2 (Volts)	DC BIAS REQUIREMENTS CURRENT Max. (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	SETTLING TIME (mSec)	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION 2nd (dBc)	TYPICAL HARMONIC SUPPRESSION 3rd (dBc)	TYPICAL SPURIOUS REFERENCE SIDEBAND SUPPRESSION (dBc)	PACKAGE	MODEL	
41 - 60	25	+5/+12	50	+5	±2	<15	-100/-120	15	15	60	197	**SPLL41SA**	Θ
121 - 176	12.5	+5/+12	40	+5	±2	<15	-105/-125	15	15	60	197	**SPLL121SA**	Θ
139 - 196	16	+5/+5	45	0	±3	<15	-95/-120	20	15	60	124S	**SPLL139SA**	Θ
291 - 325	50	+5/+5	45	0	±3	<15	-95/-120	20	15	60	124S	**SPLL291SA**	Θ
291 - 310	5	+5/+5	45	+5	±1	<50	-100/-120	20	15	60	124SL	**SPLL291SB**	Ξ
304 - 307	25	+5/+5	35	0	±3	<15	-110/-130	20	15	60	124S	**SPLL304SA**	Θ
376 - 383	25	+5/+5	35	0	±3	<15	-110/-135	20	15	60	124S	**SPLL376SA**	Θ
392 - 411	25	+5/+5	35	0	±3	<15	-95/-120	15	15	60	124SL	**SPLL392SA**	Θ
400 - 750	250	+5/+15	45	+5	±3	<5	-95/-120	10	15	60	198	**SPLL400SA**	Φ♦
477 - 512	25	+5/+5	45	0	±1	<15	-95/-120	10	15	60	124SL	**SPLL477SA**	¥
490 - 525	50	+5/+5	45	0	±3	<15	-110/-135	20	15	60	124S	**SPLL490SA**	¥
550 - 850	25	+5/+15	45	0	±3	<15	-100/-125	10	15	60	124S	**SPLL500SA**	¥
565 - 595	50	+5/+5	45	0	±3	<15	-95/-120	15	15	60	124S	**SPLL565SA**	¥
595 - 605	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL595SA**	¥
630 - 730	25	+5/+15	45	+5	±2	<15	-100/-120	15	15	60	124S	**SPLL630SA**	¥
695 - 705	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL695SA**	¥

COMMON SPECIFICATIONS

Output Impedance: 50 ohms *Reference Input Frequency : 5 to 40 MHz
Reference Input Voltage: >0.5 V p-p

Operating Temperature:-20°C to +70°C
Contact the factory for more stringent operating temperature range

*** - Must be a multiple of the step size**
¥ - Programming Type - Same programming as National Semiconductor LMX2320 chip
Φ - Programming Type - Same programming as National Semiconductor LMX2325 chip
Θ - Programming Type - Same programming as National Semiconductor LMX2332A chip, IF section
Ξ - Programming Type - Same programming as Peregrine Semiconductor PE3282A fractional N PLL chip.

PIN-OUT TABLE

RF Out	Vcc1	Vcc2	Clock In	Latch Enable Input	Data In	F_{ref} In	Lock Detect Output	§ External V_{tune}	Ground Style	Package
13	12	16	1	4	5	8	9	--	2,3,14,15	124SL,124S
25	17,23,27	2	8	12	10	19	15	33	All Other	198
5	16	18	11	12	9	14	7	--	All Other	197

Note:
♦ - External V_{tune} Normally not connected

For pin location and package outline drawings, see back pages.

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SURFACE-MOUNT

FREQUENCY RANGE (MHz)	STEP SIZE (KHz)	DC BIAS REQUIREMENTS Vcc1 & 2 (Volts)	DC BIAS REQUIREMENTS CURRENT Max. (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	SETTLING TIME (mSec)	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION 2nd (dBc)	TYPICAL HARMONIC SUPPRESSION 3rd (dBc)	TYPICAL SPURIOUS REFERENCE SIDEBAND SUPPRESSION (dBc)	PACKAGE	MODEL	
779 - 806	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL779SA**	¥
800 - 900	30	+5/+5	45	+3	±3	<15	-100/-125	20	15	60	124S	**SPLL800SA**	¥
827 - 860	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL827SA**	¥
845 - 870	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL845SA**	¥
869 - 894	30	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL869SA**	¥
895 - 905	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL895SA**	¥
914 - 941	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL914SA**	¥
939 - 964	25	+5/+5	45	0	±3	<15	-95/-120	15	15	60	124S	**SPLL939SA**	¥
950 - 1050	100	+5/+5	45	0	±3	<15	-95/-115	20	15	60	124S	**SPLL950SA**	¥
950 - 1550	1000	+5/+15	45	+5	±3	<15	-86/-106	10	15	60	124S	**SPLL950SB**	Φ
962 - 995	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL962SA**	¥
980 - 1005	25	+5/+5	35	0	±3	<15	-105/-130	20	15	60	124S	**SPLL980SA**	¥

COMMON SPECIFICATIONS

Output Impedance: 50 ohms *Reference Input Frequency : 5 to 40 MHz
Reference Input Voltage: >0.5 V p-p

Operating Temperature:-20°C to +70°C
Contact the factory for more stringent operating temperature range

*** - Must be a multiple of the step size**
¥ - Programming Type - Same programming as National Semiconductor LMX2320 chip
Φ - Programming Type - Same programming as National Semiconductor LMX2325 chip

PIN-OUT TABLE

RF Out	Vcc1	Vcc2	Clock In	Latch Enable Input	Data In	F_{ref} In	Lock Detect Output	§ External V_{tune}	Ground Style	Package
13	12	16	1	4	5	8	9	--	2,3,14,15	124S

For pin location and package outline drawings, see back pages.

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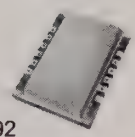
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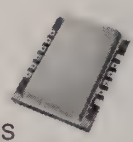
192S

SURFACE-MOUNT

FREQUENCY RANGE (MHz)	STEP SIZE (KHz)	DC BIAS REQUIREMENTS Vcc1 & 2 (Volts)	DC BIAS REQUIREMENTS CURRENT Max. (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	SETTLING TIME (mSec)	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION 2nd (dBc)	TYPICAL HARMONIC SUPPRESSION 3rd (dBc)	TYPICAL SPURIOUS REFERENCE SIDEBAND SUPPRESSION (dBc)	PACKAGE	MODEL	
101 - 109	100	+5/+5	40	0	±3	<15	-105/-125	10	10	60	192S	**JPLL100SA**	Θ
136 - 146	50	+5/+5	40	0	±3	<15	-95/-120	20	15	60	192S	**JPLL135SA**	Θ
162 - 172	50	+5/+5	40	0	±3	<15	-95/-120	20	15	60	192S	**JPLL161SA**	Θ
700 - 730	30	+5/+5	40	0	±3	<15	-100/-125	15	15	60	192	**JPLL700SA**	¥
750 - 780	30	+5/+5	40	0	±3	<15	-95/-120	15	15	60	192	**JPLL750SA**	¥
820 - 850	30	+5/+5	40	0	±3	<15	-95/-120	15	15	60	192	**JPLL820SA**	¥
944 - 952	25	+5/+5	45	0	±3	<15	-90/-125	15	15	60	192	**JPLL944SA**	¥

COMMON SPECIFICATIONS

Output Impedance: 50 ohms *Reference Input Frequency: 5 to 40 MHz Operating Temperature:-20°C to +70°C
Reference Input Voltage: >0.5 V p-p ***Contact the factory for more stringent operating temperature range***

*** - Must be a multiple of the step size**
¥ - Programming Type - Same programming as National Semiconductor LMX2320 chip
Φ - Programming Type - Same programming as National Semiconductor LMX2325 chip
Θ - Programming Type - Same programming as National Semiconductor LMX2332A chip, IF section

PIN-OUT TABLE

RF Out	Vcc1	Vcc2	Clock In	Latch Enable Input	Data In	F_{ref} In	Lock Detect Output	Ground	Package Style
7	5	1	10	12	11	3	9	2,4,6,8	192
7	1	2	12	10	11	4	8	3,5,6,9	192S

For pin location and package outline drawings, see back pages.

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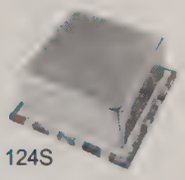
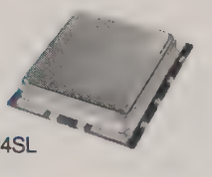

124S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197

FREQUENCY RANGE (MHz)	STEP SIZE (KHz)	DC BIAS REQUIREMENTS Vcc1 & 2 (Volts)	DC BIAS REQUIREMENTS CURRENT Max. (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	SETTLING TIME (mSec)	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION 2nd (dBc)	TYPICAL HARMONIC SUPPRESSION 3rd (dBc)	TYPICAL SPURIOUS REFERENCE SIDEBAND SUPPRESSION (dBc)	PACKAGE	MODEL
1000 - 1800	20	+5/+15	50	+5	±2	<15	-90/-115	15	15	60	197	**SPLH1000SA** Φ
1000 - 2000	1000	+5/+15	35	+5	±2	<15	-92/-120	10	15	60	124S	**SPLH1000SB** Φ
1000 - 2000	100	+5/+18	40	+5	±2	<20	-92/-120	10	15	50	197	**SPLH1000SD** Φ
1290 - 2000	100	+5/+15	45	+5	±2	<15	-95/-120	10	15	60	124S	**SPLH1290SA** Φ
1400 - 1600	100	+5/+15	45	+5	±2	<15	-95/-120	20	15	60	124S	**SPLH1400SA** Φ
1470 - 2070	25	+5/+15	45	+5	±3	<15	-90/-110	10	15	60	124S	**SPLH1470SA** Φ
1485 - 1635	250	+5/+10.5	45	+5	±3	<20	-95/-120	10	15	60	197	**SPLH1485SA** Φ
1500 - 2050	1500	+5/+15	45	+5	±2	<15	-95/-120	10	15	60	124S	**SPLH1500SA** Φ
1525 - 1560	10	+5/+5	45	0	±3	<15	-100/-125	20	15	60	124S	**SPLH1525SA** ¥
1685 - 1780	50	+5/+5	35	0	±3	<20	-90/-115	10	15	60	124S	**SPLH1685SA** Φ
1750 - 2250	1500	+5/+15	45	+5	±3	<20	-86/-106	10	15	60	124S	**SPLH1750SA** Φ
1880 - 1940	50	+5/+5	45	0	±3	<15	-95/-120	10	15	60	124S	**SPLH1880SA** Φ
1885 - 1975	50	+5/+5	35	0	±3	<20	-90/-115	10	15	60	124S	**SPLH1885SA** Φ
1900 - 2100	1000	+5/+15	45	+5	±2	<15	-86/-106	10	15	60	124S	**SPLH1900SB** Φ
1900 - 2400	100	+5/+15	35	+5	±2	<15	-90/-110	10	15	60	124S	**SPLH1900SA** Φ
2000 - 2060	50	+5/+5	45	0	±3	<15	-95/-120	10	15	60	124S	**SPLH2000SA** Φ
2050 - 2600	1500	+5/+15	45	+5	±3	<15	-87/-106	10	15	60	124S	**SPLH2050SA** Φ
2115 - 2230	250	+5/+10.5	45	+5	±3	<20	-95/-120	10	15	60	197	**SPLH2115SA** Φ
2330 - 2540	1000	+5/+12	45	0	±2	<10	-90/-115	10	15	60	124S	**SPLH2330SA** Φ
2420 - 2480	1000	+5/+5	45	0	±2	<10	-90/-110	10	15	60	124SL	**SPLH2400SA** Φ

COMMON SPECIFICATIONS

Output Impedance: 50 ohms *Reference Input Frequency : 5 to 40 MHz
Reference Input Voltage: >0.5 V p-p

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range

*** - Must be a multiple of the step size**
¥ - Programming Type - Same programming as National Semiconductor LMX2320 chip
Φ - Programming Type - Same programming as National Semiconductor LMX2325 chip

PIN-OUT TABLE

RF Out	Vcc1	Vcc2	Clock In	Latch Enable Input	Data In	F_{ref} In	Lock Detect Output	Ground	Package Style
13	12	16	1	4	5	8	9	2,3,14,15	124SL,124S
5	16	18	11	12	9	14	7	All Others	197

For pin location and package outline drawings, see back pages.

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SURFACE-MOUNT HIGH FREQUENCY

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FREQUENCY RANGE (MHz)	STEP SIZE (KHz)	DC BIAS REQUIREMENTS Vcc1 & 2 (Volts)	DC BIAS REQUIREMENTS CURRENT Max. (mA)	OUTPUT POWER dBm	OUTPUT POWER Tolerance (dB)	SETTLING TIME (mSec)	TYPICAL PHASE NOISE dBc/Hz Offset at 10 KHz/100 KHz	TYPICAL HARMONIC SUPPRESSION 2nd (dBc)	TYPICAL HARMONIC SUPPRESSION 3rd (dBc)	TYPICAL SPURIOUS REFERENCE SIDEBAND SUPPRESSION (dBc)	PACKAGE	MODEL	
1705 - 1780	50	+5/+5	45	0	±3	<15	-90/-115	10	15	60	192	**JPLH1705SA**	¥
1710 - 1770	30	+5/+5	45	0	±3	<15	-90/-115	10	15	60	192	**JPLH1710SA**	¥
1760 - 1830	50	+5/+5	45	0	±3	<15	-90-115	10	15	60	192	**JPLH1760SA**	¥
1775 - 1885	625	+5/+5	40	0	±3	<15	-95/-120	10	15	60	192	**JPLH1775SA**	Φ
1790 - 1850	30	+5/+5	45	0	±3	<15	-90/-115	10	15	60	192	**JPLH1790SA**	¥
1850 - 1910	50	+5/+5	45	0	±3	<15	-90/-115	10	15	60	192	**JPLH1850SA**	¥
1880 - 1960	625	+5/+5	40	0	±3	<15	-95/-120	10	15	60	192	**JPLH1880SA**	Φ
2060 - 2140	50	+5/+5	45	0	±3	<15	-90/-115	10	15	60	192	**JPLH2060SA**	Φ
2320 - 2400	625	+5/+5	40	0	±3	<15	-95/-120	10	15	60	192	**JPLH2320SA**	Φ
2440 - 2470	1000	+5/+5	40	0	±2	<15	-90/-115	15	15	60	192	**JPLH2440SA**	Φ

COMMON SPECIFICATIONS

Output Impedance: 50 ohms *Reference Input Frequency : 5 to 40 MHz
Reference Input Voltage: >0.5 V p-p

Operating Temperature: -20°C to +70°C
Contact the factory for more stringent operating temperature range

*** - Must be a multiple of the step size**
¥ - Programming Type - Same programming as National Semiconductor LMX2320 chip
Φ - Programming Type - Same programming as National Semiconductor LMX2325 chip

PIN-OUT TABLE

RF Out	Vcc1	Vcc2	Clock In	Latch Enable Input	Data In	F_{ref} In	Lock Detect Output	Ground	Package Style
7	5	1	10	12	11	3	9	2,4,6,8	192

For pin location and package outline drawings, see back pages.

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INTRODUCTION

Radiocommunication requires that we shift a baseband information signal to a frequency or frequencies suitable for electromagnetic propagation to the desired destination. At the destination, we reverse this process, shifting the received radiofrequency signal back to baseband to allow the recovery of the information it contains. This frequency-shifting function is traditionally known as *mixing*; the stages that perform it, as *mixers*. Any device that exhibits amplitude-nonlinear behavior can serve as a mixer, as nonlinear distortion results in the production, from the signals present at the input of a device, of signals at new frequencies. Even a rusty screw or bolt on an antenna element can act as a mixer, producing unwanted IMD products that appear at the receiver input.

Although mixers are equally important in wireless transmission and reception, traditional mixer terminology favors the receiving case because mixing was first applied as such in receiving applications. Thus, the signal to be frequency-shifted is applied to the mixer's *RF* port, and the frequency-shifting power or voltage (from a *local oscillator* [*LO*]) is applied to the mixer's LO port, resulting in two outputs at the mixer's *intermediate frequency* (*IF*) port. If the wanted IF is lower in frequency than the RF signal, the mixer is a *downconverter*; if the wanted IF is higher than the RF, the mixer is an *upconverter*. *Converter* may also be used as a term for a single stage that simultaneously acts as mixer and LO.

For a given RF signal, an ideal mixer with a perfect LO (that is, an LO with no harmonics and no noise sidebands) would produce only two IF outputs : one at the frequency sum of the RF and LO, and another at the frequency difference between the RF and LO. Filtering can be used to select the desired IF product and reject the unwanted one, which is sometimes referred to as the *IF image*.

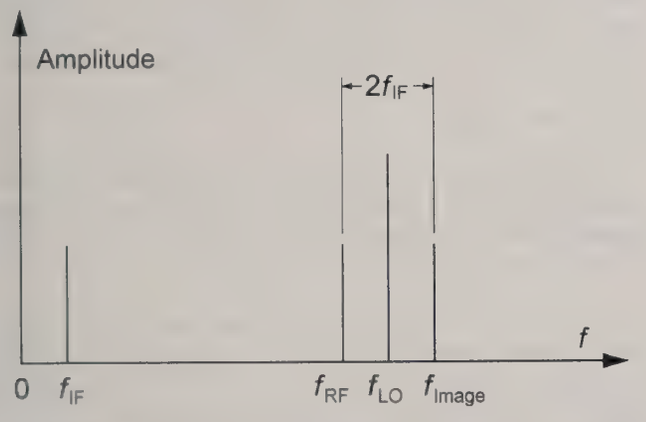

Figure 1 - Relationship between a mixer's image and desired-signal responses. The image is $2f_{IF}$ away from the desired signal.

The simultaneous generation of LO+RF and LO–RF outputs results not from a departure of mixer performance from the ideal, but from the mathematics of mixing itself. Another unavoidable mixing artifact, the *RF image* response, also results from the mathematics of mixing rather than mixer nonideality. Just as a given RF/LO combination produces two IF outputs (LO+RF and LO–RF, the IF and iF image), the mixer will produce output at the desired IF (LO+RF *or* LO–RF) in response to *two* possible RF inputs: one at LO+IF and another at LO–IF (Figure 1). The undesired response, the *RF image* (traditionally referred to merely as the *image*), is $2f_{IF}$ removed from the desired response. Even if no manmade signals exist at the RF image frequency, reducing a mixer's RF image response can be important because noise at that frequency, including that produced by circuitry between the mixer and antenna, will still be mixed to the desired IF, degrading the signal-to-noise ratio. Filtering and phasing techniques can be used to reduce the RF or IF image responses—filtering if the image is sufficiently removed from the desired response for filtering to provide the necessary rejection, phasing if the desired and image responses are insufficiently spaced for filtering to work, as in the case of a double-conversion receiver in which signals at a high first IF (for example, 50 to 70 MHz), must be converted to a very low first IF, such as 25 kHz.

The output of every real mixer includes a vast number of additional unwanted products, including noise, the fundamentals of the mixer's RF and LO signals and their harmonics, and the sums and differences of the RF and LO and their harmonics. Intermodulation distortion between multiple signals present at the RF port, and IF output resulting from the mixing to IF of LO noise-sideband energy by strong adjacent signals further complicate a mixer's output spectrum and may compromise system performance.

All mixers are *multipliers* in the sense that the various new outputs they produce can be described mathematically as the multiplicative products of their inputs.

Let us now consider the basic theory of mixers. Mixing is achieved by the application of two signals to a nonlinear device. Depending upon the particular device, the nonlinear characteristic may differ. However, it can generally be expressed in the form:

$$I = K(V + v_1 + v_2)^n \qquad (1\text{-}1)$$

The exponent n is not necessarily an integer, V may be a dc offset voltage, and the signal voltages v_1 and v_2 may be expressed as $v_1 = V_1 \sin(\omega_1 t)$ and $v_2 = V_2 \sin(\omega_2 t)$.

When $n = 2$, (1-1) may then be written as:

$$I = K[V + V_1 \sin(\omega_1 t) + V_2 \sin(\omega_2 t)]^2 \qquad (1\text{-}2)$$

This assumes the use of a device with a square-law characteristic. A different exponent will result in the generation of other mixing products, but this is not relevant for a basic understanding of the process. Expanding (1-2),

$$I = K[V^2 + V_1^2 \sin^2(\omega_1 t) + V_2^2 \sin^2(\omega_2 t) + 2V V_1 \sin(\omega_1 t) + 2V V_2 \sin(\omega_2 t) + 2V_2 V_1 \sin(\omega_2 t)\sin(\omega_1 t)] \qquad (1\text{-}3)$$

The output comprises a direct current and a number of alternating current contributions. We are interested only in that portion of

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the current that generates the IF; so, if we neglect those terms that do not include both V_1 and V_2, we may write:

$$I_{IF} = 2\,K\,V_1\,V_2 \sin(\omega_1 t)\sin(\omega_2 t)$$
$$I_{IF} = K\,V_2\,V_1\{\cos[(\omega_2 - \omega_1)t] - \cos[(\omega_2 + \omega_1)t]\} \quad (1\text{-}4)$$

This means that at the output, we have the sum and difference signals available, and the one of interest may be selected by the IF filter.

PROPERTIES OF MIXERS

1-1-1 Conversion Gain/Loss

Even though a mixer works by means of amplitude-nonlinear behavior in its device(s), we generally want (and expect) it to act as a linear frequency shifter. The degree to which the frequency-shifted signal is attenuated or amplified is an important mixer property. *Conversion gain* can be positive or negative; by convention, negative conversion gains are often stated as *conversion loss*.

In the case of a diode (passive) mixer, the insertion loss is calculated from the various loss components:

Loss (dB) = Conversion Loss + Transformer Loss
+ Losses due to harmonic generation + Diode Loss (1-5)

In the case of a doubly balanced mixer, we must add the transformer losses (on both sides) and the diode losses as well as the mixer sideband conversion, which accounts, by definition, for 3 dB. Ideally, the mixer produces only one upper and one lower sideband, which results in the 3-dB loss compared to the input signal. Also, the input and output transformers add about 0.75 dB on each side, and of course there are the diode losses because of the series resistances of the diodes. This total loss is still defined as conversion loss for all Synergy mixers.

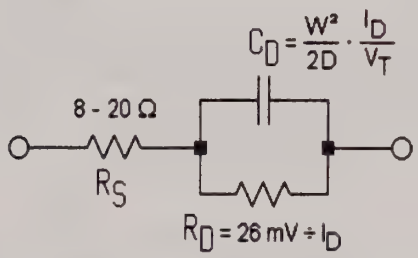

Figure 2—Equivalent circuit of a mixer diode.

Figure 2 shows the equivalent circuit of a diode. It consists of a series (loss) resistor R_S and a time-variable electronic resistor, typically called the *diffusion resistance*, R_D, and a capacitance C_D shunting R_D. C_D can be found from

$$C_D = \frac{W^2}{2D}\frac{I_D}{V_T} \quad (1\text{-}6)$$

where D is the diffusion constant, a material-dependent value, and W is the physical width. The average value for R_D is somewhere between the calculated value of 26 mV/I_D and some leakage current, simply because it is generated by a rectification mechanism, which turns the LO power into an RF current and then into a combination of dc and RF currents.

We can calculate the diode loss according to:

$$\text{Diode Loss (dB)} = \log 10\left(\frac{50 + (2 \times R_S)}{50}\right) \quad (1\text{-}7)$$

Assuming that R_S = 8 Ω, the diode loss for a diode-ring mixer,

$$\text{Diode Loss (dB)} = \log 10\left(\frac{50 + (2 \times 8)}{50}\right) = 0.5\text{ dB} \quad (1\text{-}8)$$

From (1-5), the insertion loss for this mixer is therefore:

Loss (dB) = 3 dB (conversion loss) +
1.5 dB (transformer loss) +
1 dB (losses from harmonic generation) +
0.5 dB (diode loss) = 6 dB (1-9)

This assumes mixing at the fundamental frequency. Sometimes the diode loss resistor R_S is as high as 25 Ω per arm (as in a MOSFET switch), or 50 Ω total. This now results in

Loss (dB) = 3 dB + 1.5 dB +
1 dB + 3 dB = 8.5 dB (Insertion Loss) (1-10)

Since the value of R_S is partially determined by the threshold voltage of the diode and the diode diffusion resistance, R_D, a wide range of values can be noticed for different drive levels and mixer topologies. Figure 2 shows a shunt capacitance C_D, the so-called *diode diffusion capacitance*. When the diode is conducting, the influence of this nonlinearity is frequency-dependent, which adds to the insertion loss. In this discussion we have not considered its frequency-dependency. At wireless frequencies, modern Schottky diodes, also frequently called *hot-carrier* diodes, are operated far from their cutoff frequency, resulting in less than 1 dB of additional losses. There are also mixers with special circuitry to terminate the IF image. This is done with a diplexer circuit or equivalent circuitry.

1-1-2 Noise Figure

Like any network, a mixer contributes noise to the signals its frequency-shifts. The degree to which a mixer's noise degrades the signal-to-noise ratio of the signals its frequency-shifts is evaluated in terms of noise factor and noise figure.

For a long time, the literature has stated that the noise figure of a passive mixer, which is pretty much independent of its circuit arrangement, is equal to the mixer's conversion loss. But this neglects the influence of the white-noise contribution of the mixer's diode(s). This is ironic, considering that RF noise generators were long based on thermionic diodes operated in saturation (the 5722 noise diode was a popular type). Such a diode's noise-power output can be readily determined from its saturation current. On the other hand, all Schottky diodes, while conducting, generate white noise that follows the same principle as above. This fact has been practically recognized only by a few companies that make modern noise-measurement equipment. Modern noise-measurement devices measure the noise figure of a system by "hot and cold" technique, an approach based on knowledge of the absolute noise

energy emitted under hot conditions (conductance). This method has the advantage that it can be used up to several tens of gigahertz, while the old vacuum-tube-based noise generators ran out of steam at around 1 GHz due to the inability to match the tube to the 50-Ω termination. This was typically accomplished by connecting a 50-Ω resistor between anode and ground (without dc connection), followed by a low-pass filter, which would match the tube capacitance and other parasitics to the required termination of 50 Ω, purely resistive.

In reality, we can take the loss calculation from above and add the Schottky noise generated by the diodes as they are driven by the local oscillator.

If a Schottky diode is used as a noise generator in the conductive mode, it generates a continuous frequency spectrum, possibly up to several gigahertz. There is a mathematical relationship between the noise power spectrum emitted by the diode and the time-averaged current of this diode, which generates the noise. If the noise source impedance is set (typically 50 Ω), the available noise power can be calculated according to:

$$I_R = \sqrt{2e \times I_s \times \Delta f} \tag{1-11}$$

where
$e = 1.6 \times 10^{-19}$ coulombs
I_s = saturation current of the diode
Δf = effective noise bandwidth
For $S_{11} = 0$ or proper termination of this circuit ($R_G = R_{term}$):

$$P_R = \left(\frac{I_R}{2}\right)^2 \times R_i = \frac{e}{2} \times I_s \times \Delta f \times R_i \tag{1-12}$$

Calculated at a bandwidth of 1 Hz:

$$\frac{P_R}{\Delta f} = \frac{e}{2} \times I_s \times R_i \tag{1-13}$$

If

$$\frac{P_R}{\Delta f} = kT_0 \times F \tag{1-14}$$

the noise factor becomes

$$F = \frac{e \times I_s \times R_i}{2kT_0} \tag{1-15}$$

If the values for e and kT_0 are inserted,

$$F = 20 \times I_D \times \frac{26\,\text{mV}}{I_D} + \frac{R_S + R_G}{2R_G} \tag{1-16}$$

Example. Assume the passive mixer mentioned above with its 6-dB conversion loss is considered and a dc current of 15 mA results as a function of the LO drive. Since I_D gets cancelled, the noise factor (F) of the diode portion equals

$$\begin{aligned} F &= 20 \times I_D \times \frac{26\,\text{mV}}{I_D} + \frac{R_S + R_G}{2R_G} \\ &= 0.52 + 0.58 \\ &= 1.1 \end{aligned} \tag{1-17}$$

The noise figure, NF, is 10 log F, or 0.413 dB. Now this number and the insertion loss must be added. The resulting noise figure would be 6.413 dB. This is consistent with published measurement data.

Exact mathematical nonlinear approach. The exact noise factor of a real mixer is computed by the formula

$$F = \frac{N_0(\omega_{IF}) + kT_0}{K_B T_0 G_{Tc}(\omega_{RF})} \tag{1-18}$$

where

$N_0(\omega_{IF})$ = total noise power (per unit bandwidth) delivered to the IF load at intermediate frequency
K_B = Boltzmann's constant
T_0 = Reference temperature (290 or 300 K is commonly used)
$G_{Tc}(\omega_{RF})$ = Transducer conversion gain from ω_{RF} to ω_{RF}.
Let us now further elaborate on (1-18). We may write

$$N_0(\omega_{IF}) = N_S(\omega_{IF}) + N_{INT}(\omega_{IF}) + N_L(\omega_{IF}) + kT_0 \tag{1-19}$$

where N_S is noise-generated by the RF source resistance and transferred to the IF load through frequency conversion, N_{INT} is noise generated internally to the mixer, and N_L is noise generated by the IF termination. If the source resistance is held at temperature T_0, N_S will basically originate from noise generated at the RF and image frequencies, which are transferred to the IF with approximately the same conversion loss, plus a relatively small contribution transferred from other sidebands with a smaller conversion loss. We may then write synthetically

$$N_S(\omega_{IF}) = 2aK_B T_0 G_{Tc}(\omega_{RF}) \tag{1-20}$$

where a is a coefficient slightly larger than 1. $N_{INT}(\omega_{RF})$ is generated by transformer losses, by the diode Schottky noise and by the diode resistive parasitics, and in principle may take on any value; in particular, it may be zero if both the transformers and the diodes are ideal (that is, if the latter are pure nonlinear resistors). As for $N_L(\omega_{IF})$, by Nyquist's theorem the IF load resistor R_L may be described as a noiseless resistor in series with a noise voltage source whose

mean-square voltage (per unit bandwidth) is

$$|V_L|^2 = 4K_B T_L R_L \tag{1-21}$$

where T_L is the IF termination temperature. If the IF load is driven by a source with an output impedance $Z_{out}(\omega_{IF})$, the noise power actually delivered to the load will obviously be

$$N_{out} = \frac{4K_B T_L R_L^2}{|Z_{out}(\omega_{IF}) + R_L|^2} \tag{1-22}$$

In addition to N_{out}, the thermal noise originating from the IF termination delivered to the IF load at ω_{IF} will also include contributions from other sidebands that are back-converted by the mixer nonlinearities with a relatively small conversion gain. Thus we may write

$$N_L(\omega_{IF}) = \frac{4bK_B T_L R_L^2}{|Z_{out}(\omega_{IF}) + R_L|^2} \tag{1-23}$$

where b is slightly larger than 1. If we now introduce the mixer conversion loss, namely

$$L_C = \frac{1}{G_{Tc}(\omega_{RF})} \tag{1-24}$$

and combine (1-18) with (1-19), (1-20) and (1-23), we finally get the noise factor expression

$$F = 2a + \frac{N_{INT}(\omega_{IF}) + kT}{K_B T_0} L_C + \frac{4bT_L R_L^2}{T_0 |Z_{out}(\omega_{IF}) + R_L|^2} L_C \tag{1-25}$$

In the normal region of operation of the mixer (sufficient LO drive) we may assume

$$Z_{out}(\omega_{IF}) R_L \tag{1-26}$$

so that (1-25) becomes

$$F = 2a + \frac{N_{INT}(\omega_{IF}) + kT}{K_B T_0} L_C + \frac{bT_L}{T_0} L_C \tag{1-27}$$

Multiplying the $\log_{10}$ of F by 10 gives us the exact mixer noise figure in dB.

Table 1-1 shows how the noise figure and conversion loss vary with LO power for a generic diode DBM (Figure 3). "Starving" a diode mixer by decreasing its LO drive rapidly degrades its performance in all respects.

Table 1-1 Noise Figure and Conversion Loss versus LO Power for a Diode DBM

LO Power (dBm)	*NF* (dB)	*Conversion Loss* (dB)
–10.0	45.3486	–45.1993
–8.0	32.7714	–32.5264
–6.0	19.8529	–19.2862
–4.0	12.1154	–11.3228
–2.0	8.85188	–8.05585
0.0	7.26969	–6.51561
2.0	6.42344	–5.69211
4.0	5.85357	–5.15404
6.0	5.50914	–4.84439
8.0	5.31796	–4.66871
10.0	5.19081	–4.54960
12.0	5.08660	–4.45887
14.0	4.99530	–4.38806
16.0	4.91716	–4.33322
18.0	4.85920	–4.29407
20.0	4.82031	–4.26763

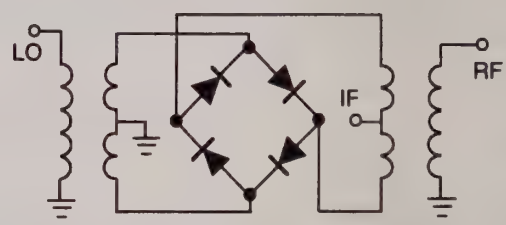

Figure 3 — Generic diode DBM.

1-1-3 Linearity

1-dB compression point. Like other networks, a mixer is amplitude-nonlinear above a certain input level; above this point, the output level fails to track input-level changes proportionally. This figure of merit, P_{-1dB}, identifies the single-tone input-signal level at which the output of the mixer has fallen 1 dB below the expected output level. The 1-dB compression point in a conventional double-balanced diode mixer is approximately 6 dB below the LO power. For Triple Balanced mixers, it is usually 3 dB below the LO power.

1-dB desensitization point. This specification is another figure of merit similar to the 1-dB compression point. However, the 1-dB desensitization point refers to the level of an interfering (undesired) input signal that causes a 1-dB decrease in nominal conversion gain for the desired signal. For a diode-ring Doulbe Balanced Mixers (DBM), the 1-dB desensitization point is usually 2 to 3 dB below the 1-dB compression point.

Dynamic range. The dynamic range of any RF/wireless system can be defined as the difference between the 1-dB compression point and the MDS (minimum discernible signal). These two points are specified in units of power (dBm), giving dynamic range in dB. When the RF input level approaches the 1-dB compression point, harmonic and intermodulation products begin to interfere with the system performance. High dynamic range is obviously desirable, but cost, power consumption, system complexity, and reliability must also be considered.

Harmonic intermodulation products (HIP). These are spurious products that are harmonically related to the f_{LO} and f_{RF} input signals.

$$\text{HIP} = Mf_{LO} + Nf_{RF} \quad (1\text{-}28)$$

Table 1-2 shows relative harmonic intermodulation product levels for a high-level diode DBM.

Intermodulation distortion (IMD). Nonlinearities in the mixer devices give rise to intermodulation distortion products whenever two or more signals are applied to the mixer's RF port. Testing this behavior with two (usually closely spaced) input signals of equal magnitude can return several figures of merit depending on how the results are interpreted. A mixer's third-order output intercept point ($IP_{3,out}$) is defined as the output power level where the spurious signals generated by $(2f_{RF1} \pm f_{RF2}) \pm f_{LO}$ and $(f_{RF1} \pm 2f_{RF2}) \pm f_{LO}$ are equal in amplitude to the desired output signal as shown in Figure 4.

Table 1-2 Typical Spurious Responses of High-Level Double-Balanced Mixer (Decibels Below $f_{LO} \pm f_{RF}$ Response)

RF Input Signal Harmonics		f_{LO}	$2f_{LO}$	$3f_{LO}$	$4f_{LO}$	$5f_{LO}$	$6f_{LO}$	$7f_{LO}$	$8f_{LO}$
$8f_{RF}$	100	100	100	100	100	100	100	100	100
$7f_{RF}$	100	97	102	95	100	100	100	90	100
$6f_{RF}$	100	92	97	95	100	100	95	100	100
$5f_{RF}$	90	84	86	72	92	70	95	70	92
$4f_{RF}$	90	84	97	86	97	90	100	90	92
$3f_{RF}$	75	63	66	72	72	58	86	58	80
$2f_{RF}$	70	72	72	70	82	62	75	75	100
f_{RF}	60	0	35	15	37	37	45	40	50
		60	60	70	72	72	62	70	70

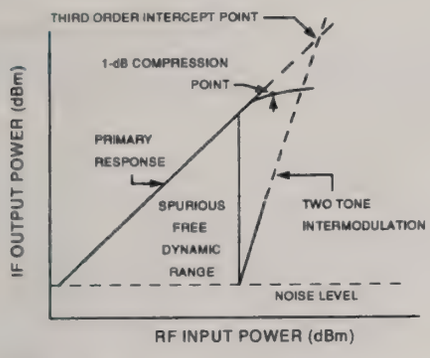

Figure 4 — Mixer linearity evaluation, including compression and two-tone IMD dynamic range. P_{-1dB} for a single-tone cannot be read directly from this graph because the values shown are the result of two-equal-tone drive.

The third order input intercept point, $IP_{3,in}$—IP_3 referred to the input level—is of particularly useful value and is the most commonly used mixer IMD figure of merit. $IP_{3,in}$ can be calculated according to:

$$IP_{n,in} = IMR_{,}(n\text{-}1) + \text{input power (dBm)} \quad (1\text{-}29)$$

where IMR is the intermodulation ratio (the difference in dB between the desired output and the spurious signal, and n is the IM order—in this case, 3). In a conventional diode double-balanced mixer, $IP_{3,in}$ is approximately 14 dB above the single-tone 1-dB compression point (P_{-1dB})—approximately 8 dB greater than the local oscillator power.

Although designers are usually more concerned with odd-order IM performance, second-order IM can be important in wideband systems (systems that operate over a 2:1 or greater bandwidth).

1-1-4 LO Drive Level

A mixer's specifications are usually guaranteed at a particular LO drive level, usually specified as a dBm value that may be qualified with a tolerance. Insufficient LO drive degrades mixer performance; excessive LO drive degrades performance and may damage mixer devices. Commercially available diode mixers are often classified by LO drive level; for example, a "Level 17" mixer requires 17 dBm of LO drive.

1-1-5 Interport Isolation

In a mixer, isolation is defined as the attenuation in dB between a signal input at any port and its level as measured at any other port. High isolation numbers are desirable. Figure 5 shows LO-to-IF and LO-to-RF isolation versus frequency for a triple-balanced diode mixer. Isolation is dependent mainly on transformer and physical symmetry, and device balance, but the level of signals applied to the mixer also plays a role, as shown in Figure 6.

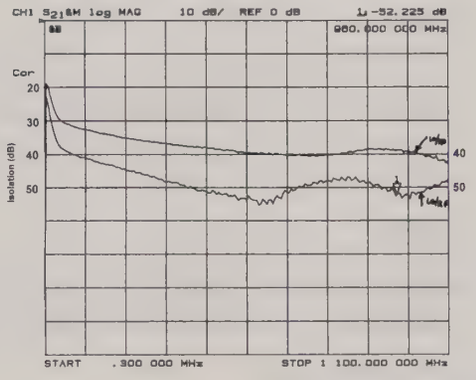

Figure 5 — LO-IF and LO-RF isolation versus frequency for a high-level triple-balanced diode mixer.

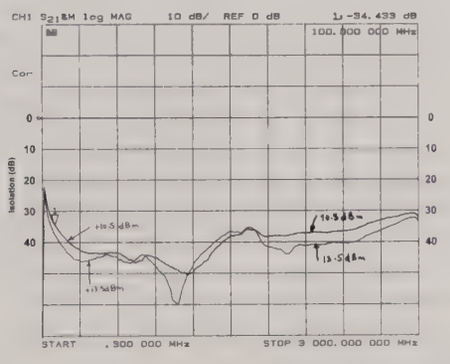

Figure 6 — LO-IF isolation versus frequency and LO drive level for a high-level diode DBM.

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1-1-6 Port VSWR

The load presented by a mixer's ports to the outside world can be of critical importance to a designer. For example, high LO-port VSWR may result in inefficient use of available LO power, resulting in LO starvation (underdrive) that degrades the mixer's performance. Figure 7 shows LO-port return loss versus frequency for a high-level diode DBM with two values of LO power. Like interport isolation, port VSWR can vary with the level of the signal applied.

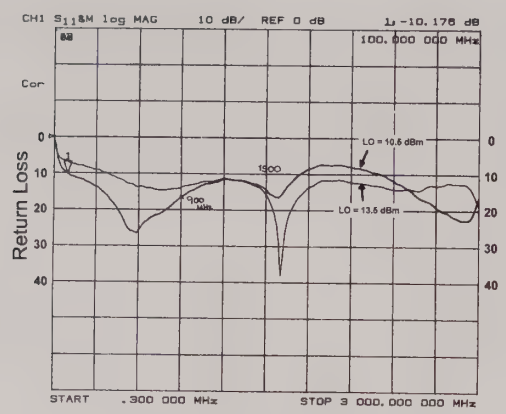
CH1 S11&M log MAG 10 dB/ REF 0 dB 1: -10.176 dB
100.000 000 MHz
Cor
Return Loss
LO = 10.5 dBm
LO = 13.5 dBm
1500
START .300 000 MHz
STOP 3 000.000 000 MHz

Figure 7 — LO-port return loss versus frequency for a high-level diode DBM.

1-1-7 Dc Offset

Isolation between ports plays a major role in reducing dc offset in a mixer. Like isolation, dc offset is a measure of the unbalance of the mixer. In phase-detector and phase-modulator applications, dc offset is a critical parameter.

1-1-8 Dc Polarity

Unless otherwise specified, mixers with dc output are designed to have negative polarity when RF and LO signals are of equal phase.

1-1-9 Power Consumption

Circuit power consumption is always important, but in battery-powered wireless designs it is *critical*. Mixer choice may be significant in determining a system's power consumption, sometimes in ways that seem paradoxical at first glance. For instance, a passive mixer might seem to be a power-smart choice because it consumes *no* power—until we factor in the power consumption of the circuitry needed to provide the (often considerable) LO power a passive mixer requires. If a mixer requires a broadband resistive termination that will be provided by a post-mixer amplifier operating at a high standing current, the power consumption of the amplifier stage must be considered as well. Evaluating the suitability of a given mixer type to a task therefore requires a grasp of its ecology as well as its specifications.

The simple single-diode-mixer circuit shown in Figure 1-1 is intended only as an illustration of the basic behavior of diode mixer. A practical single-diode mixer would include filtering at its RF, LO and IF ports—RF filtering for image rejection, reduced LO radiation and optimum matching of the RF source to the diode; LO filtering to keep RF out of the LO and optimally match the LO to the diode, and IF filtering to optimally match the diode to its IF (and IF image) load, preferably while providing some rejection of the mixer's unwanted outputs, the strongest (and most potentially troublesome) of which is the LO signal.

1-2-1 Single-Balanced Mixer

Figure 8 shows the schematic of a two-diode, *single-balanced* mixer. It performs multiplicative mixing because its RF and LO signals are applied to different ports. In this more commonly seen two-diode mixer configuration, a balanced transformer drives the diodes out of phase for the LO and in phase for signals present at the RF port. The Figure 9 shows how this mixer's conversion gain and noise figure vary with applied LO power. Figure 10 shows how the mixer's conversion loss and noise figure vary with frequency for a constant LO power.

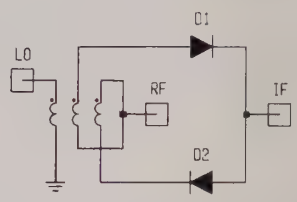

Figure 8 — Schematic of the two-diode (also known as *single-balanced*) mixer.

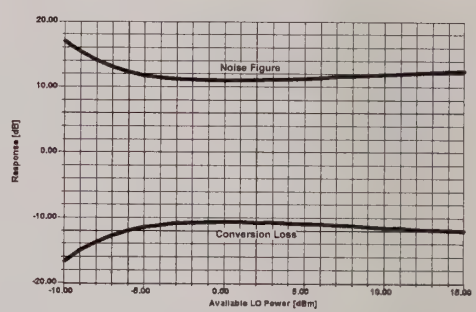

Figure 9 — How the nonideal mixer's conversion loss and noise figure vary with available LO power. In this analysis, LO =500 MHz (13 dBm), RF = 500.455 MHz (–20 dBm) and IF = 455 kHz.

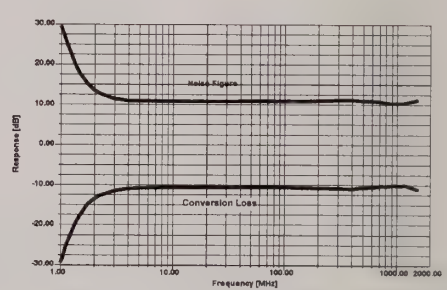

Figure 10 –How the nonideal two-diode mixer's conversion lossand noise figure vary with frequency for a constant LO power. In this analysis, LO = 1 to 1500 MHz (2 dBm), RF = 1.455 to 1500.455 MHz (–40 dBm) and IF = 455 kHz.

The two-diode mixer is used mostly in the frequency range above 1 GHz in a manner akin to a phase discriminator, using step-recovery diodes in the LO feed for enhanced harmonic mixing. Such

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mixers are mainly used in medium-cost spectrum analyzers or microwave receivers up to several tens of gigahertz, with the necessary transformers and baluns printed on the circuit board.

With perfectly matched diodes and perfect transformer and constructional symmetry, no LO energy arrives at the IF and RF ports, and there is only slight attenuation between the RF and IF ports. Both building and computer modeling such a mixer is impossible: building, because perfectly matched diodes and perfect transformer and constructional symmetry cannot be achieved in practice; computer modeling, because floating-point mathematics runs out of gas in handling the infinite amplitude spread involved in calculating the perfect cancellation of the LO signal as it travels to the RF and IF ports. That said, Figure 11 compares the mixer's *quasi*-ideal port-to-port isolation (matched diodes, a perfect transformer, no stray inductances and capacitances, and a 10-megohm resistors connected from port to port) and nonideal port-to-port isolation (slightly mismatched diodes and 0.5 pF between the upper terminal of the middle winding and ground).

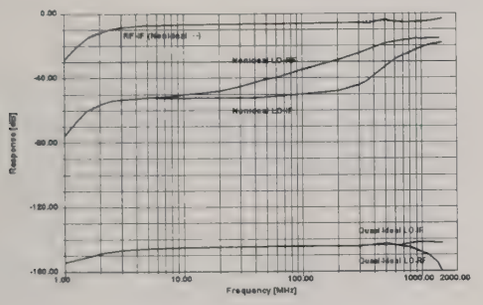

Figure 11 — Port-to-port isolation of the quasi-ideal (identical diodes and no stray capacitance) and nonideal (slightly mismatched diodes and 0.5 pF of stray capacitance between the upper terminal of the middle transformer winding and ground) two-diode mixer. In this analysis, LO = 1 to 1500 MHz (2 dBm), RF = 1.455 to 1500.455 MHz (–40 dBm) and IF = 455 kHz.

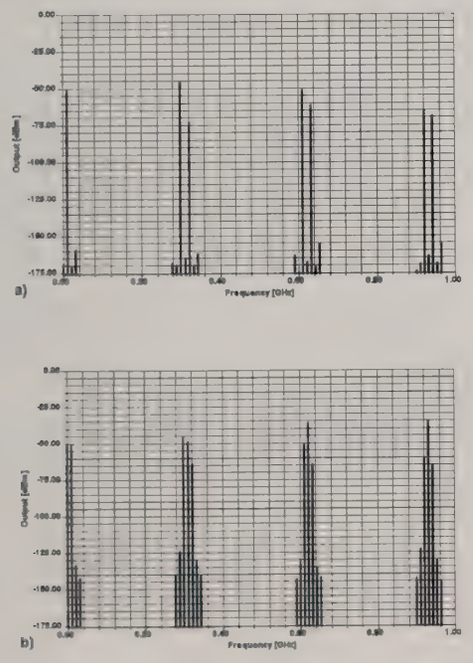

Figure 12 — The nonideal mixer's output spectrum with (a) identical diodes and no stray capacitance and (b) slightly mismatched diodes and 0.5 pF of stray capacitance between the upper terminal of the middle transformer winding and ground. In these analyses, LO = 310.7 MHz (2 dBm), RF = 300.0 MHz (–40 dBm) and IF = 10.7 MHz. Four LO harmonics and 3 LO sidebands were used.

Figures 12a and 12b show the mixer's output spectrum for the quasi-ideal and nonideal cases, respectively.

1-2-1 Subharmonically pumped single-balanced mixer.

Figure 13 shows a single-balanced mixer with a difference: antiparallel diode pairs take the place of single diodes, the RF and IF are buffered from each other only by filtering, and the LO is applied at 1/2 the frequency necessary to provide the desired frequency conversion. The RF-to-IF isolation is limited to that provided by the seriesed input and output filtering, but the LO-to-IF isolation is higher at f_{LO}, and much higher at $2f_{LO}$, than that achievable with a DBM with the LO signal at $2f_{LO}$ (Figure 14). Although the example shown is for an up-converting HF receiver, this technique finds application well into the microwave range as the basis for I/Q modulators, in which carrier leakage must be reduced to a level difficult to achieve with conventional DBMs.

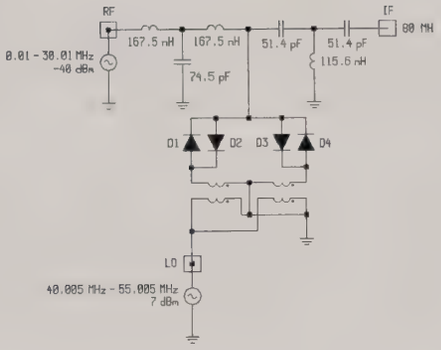

Figure 13 — A subharmonically pumped single-balanced mixer using antiparallel diode pairs. The LO operates from 40.005 - 55.005 MHz to mix 0.01 - 30.01-MHz RF to an IF of 80 MHz.

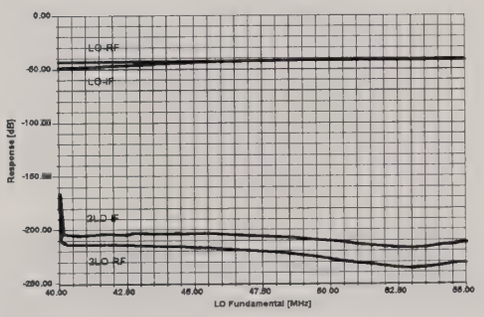

Figure 14 —Simulated interport isolation of the subharmonic SBM. For realism, the diodes and transformers are slightly mismatched.

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2-1-1 Diode-Ring Double Balanced Mixer

Adding two more diodes and another transformer to the singly balanced mixer results in a double-balanced mixer (DBM) as shown in Figure 15. A DBM's frequency response is largely determined by the frequency response of its transformers. The low-frequency limit is determined by the inductance of the transformer windings, the reactance of which, at the lowest frequency of interest, should be at least four times the impedance at which the transformer operates. The upper frequency limit is determined mainly by the degradation of the transformers' transmission-line behavior at higher frequencies, although the increasing importance of diode capacitance also plays a role.

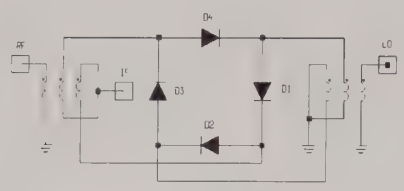

Figure 15 —Schematic of the diode-ring doubly balanced mixer.

A DBM's interport isolation is determined by the symmetry of its transformers, diodes and physical construction. In practice, the effects of diode mismatch can by minimized by using a diode quad ring crossover with closely matched diode.

Figure 16 shows how the DBM's conversion loss and noise figure vary with applied LO power. Figure 17 shows how the DBM's conversion loss and noise figure vary with frequency for an LO power of 7 dBm, with quasi-ideal and nonideal balance. Figure 18 shows how the DBM's port-to-port isolation differs with quasi-ideal and nonideal balance for an LO power of 7 dBm. Figure 19 shows how the DBM's RF- and LO-port return loss varies with frequency; the sharp peak corresponds to a resonance caused by one of the stray capacitances added to simulate less-than-ideal balance in the modeled mixer.

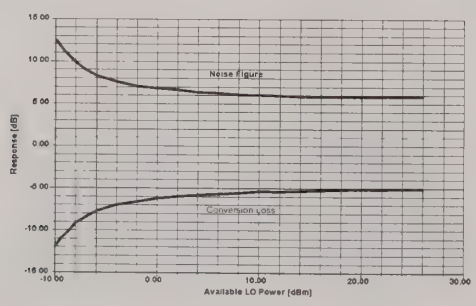

Figure 16 — DBM conversion gain and noise figure versus LO power. In this analysis, LO = 310.7 MHz (–10 to 26 dBm), RF = 300 MHz (–40 dBm) and IF = 10.7 MHz.

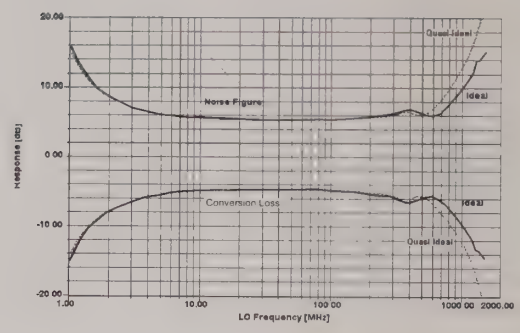

Figure 17 — This plot of conversion gain and noise figure versus frequency for quasi-ideally and nonideally balancedversions of the same DBM reveals that balance plays arelatively minor role in the CG and NF performance achieved.In these analyses, the LO (–7 dBm) sweeps from 1 MHz to 1500 MHz and the RF (–40 dBm) sweeps from 1.455 to 1500.455 MHz to produce an IF of 455

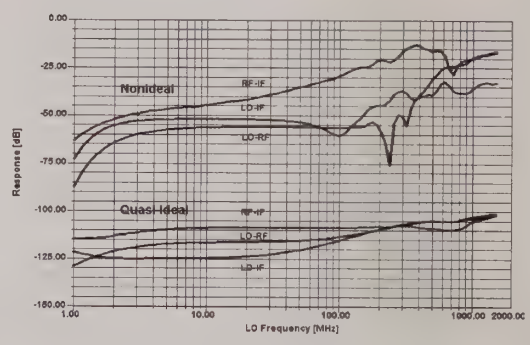

Figure 18 — Interport isolation for DBMs with quasi-ideal and nonideal balance. In these analyses, the LO (–7 dBm) sweepsfrom 1 MHz to 1500 MHz and the RF (–40 dBm) sweeps from 1.455 to 1500.455 MHz to produce an IF of 455 kHz.

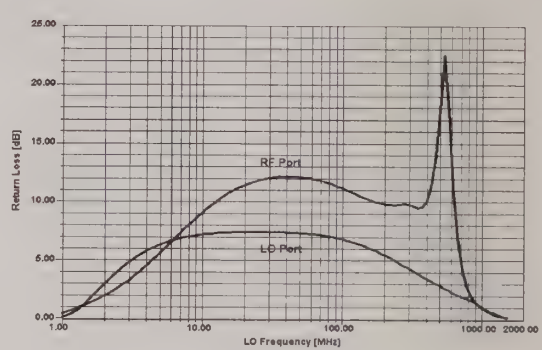

Figure 19 — Return loss versus frequency for the DBM's RF and LO ports. The sharp peak results from a stray resonance.

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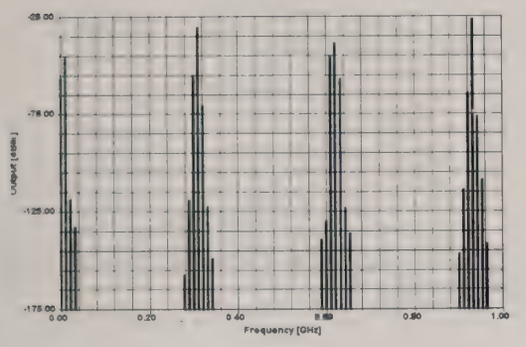

Figure 20 — Output spectrum of a nonideally balanced DBM. In this analysis, LO = 310.7 MHz (–7 dBm) and RF = 300 MHz (–40 dBm) for an IF of 10.7 MHz. Four LO harmonics and 3 LO sidebands were used.

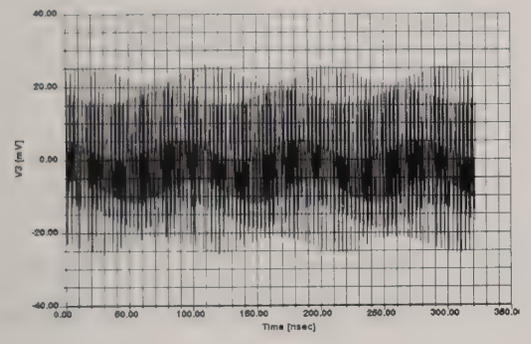

Figure 21 — IF-port voltage waveform of the DBM over 100 cycles of the LO signal. The 310.7-MHz LO and 10.7-MHz IF components are clearly evident.

Figure 20 shows the DBM's output spectrum. Figure 21 shows the DBM's output waveform over 50 cycles of the LO signal.

Two-tone testing the DBM allows us to characterize its IP_3 figures of merit. Figure 22 shows the nonideal DBM's IF and IM_3 responses for LO powers of –5, 1, 7 and 13 dBm. Figure 23 details how the DBM's IP_3 increases with LO drive, and Figure 24 shows the desired IF outputs and close third-order spurs near 10.7 MHz. Figure 25 shows the DBM's output voltage over 100 cycles of the LO signal, and Figure 26 shows the anode-cathode voltage of one of the ring's diodes, also over 100 LO cycles, both under two-tone IMD test conditions.

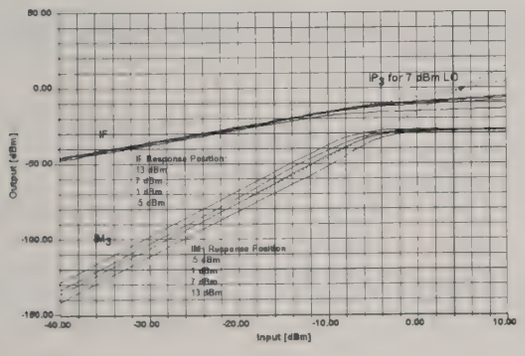

Figure 22 — Diode DBM IF and IM_3 output versus RF power for four LO-drive levels. The responses for LO = 7 dBm have been extrapolated to show IP_3. Within limits, varying a mixer's LO drive affects its linear IF output relatively little while significantly affecting IMD. See Figure 23. For all four analyses, LO = 310.7 MHz, RF1 = 300.0 MHz (–40 to 10 dBm), and RF2 = 300.3 MHz (–40 to 10 dBm); 4 LO harmonics and 3 LO sidebands were used.

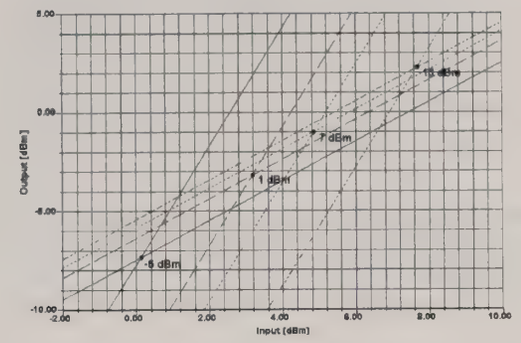

Figure 23 — Extrapolating the responses for all four LO levels represented in Figure 22 shows how varying a diode DBM's LO drive shifts its third order intercept point. Although these curves indicate that the simulated mixer's IP_3 generally increases with LO drive, the improvement in IP_3 is not as great as we might expect. The reason for this is that these four analyses, as well as the other diode-mixer analyses in this chapter, were done using diode models with a threshold voltage (V_J) of 0.23. If high-level diodes with a V_J of about 0.8 V had been used, $IP_{3,out}$ for the 13 dBm LO case shown here would increase to +13 dBm. $IP_{3,In}$ for the 13 dBm LO case would turn out to be 13 dBm + insertion loss = 13 dBm + 7 dB = 20 dBm. The issue of diode damage aside, attempting to increase IP_3 merely by driving a low- or medium-barrier diode harder eventually results in diminishing returns. High-barrier diodes are essential in getting the best IP_3 performance with high LO drive.

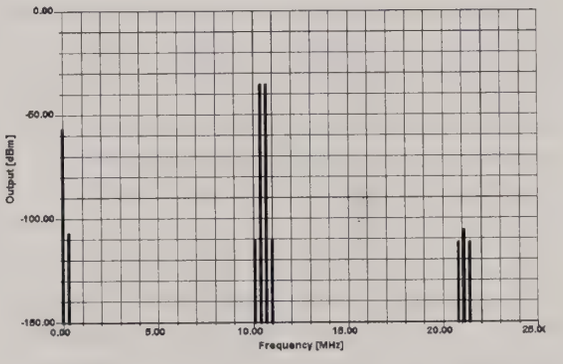

Figure 24 — The DBM's output in the 11-MHz region during two-tone testing. The third-order products are clearly visible above and below the desired output signals. The test conditions for this analysis are those for Figure 22 with LO = 13 dBm.

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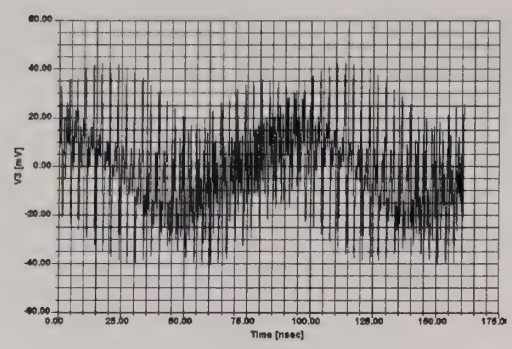

Figure 25 — The DBM's IF-output voltage over 50 cycles of the LO signal. The test conditions for this analysis are those for Figure 28 with LO = 13 dBm.

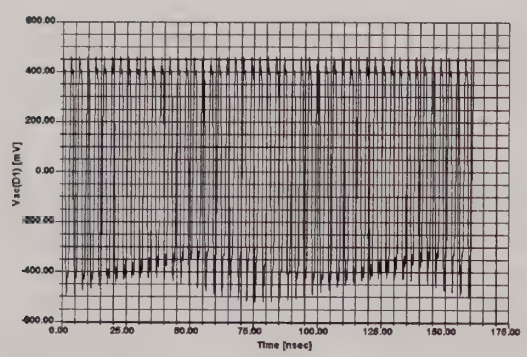

Figure 26 — The anode-cathode voltage of one of the DBM's diodes, also over 50 LO cycles under two-tone IMD test condtions. The test conditions for this analysis are those for Figure 4-28 with LO = 13 dBm.

A double-balanced mixer, unless it is termination insensitive, is extremely sensitive to nonresistive termination. This is because the transmission-line transformers do not operate properly when they are not properly terminated, and the reflected power generates high voltage across the diodes. This effect results in much higher distortion levels than in a properly terminated transformer.

2-2 Applications of mixers

2-2-1 Phase detector. Theoretically, any mixer with a dc-coupled IF port can be used as a phase detector. When two signals of equal frequency are applied simultaneously to the reference and incoming signal ports, the phase detector produces a dc output at the IF port proportional to the cosine of the phase difference (Figure 28).

2-2-2 Binary phase-shift keying (BPSK) modulator. Binary phase modulation occurs when a positive and negative signal current shifts the RF carrier between 0 and 180°. Figure 29 shows a double-balanced mixer operating as a BPSK modulator.

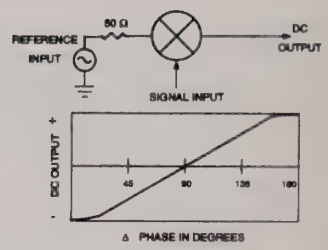

Figure 28 — A mixer with a dc-coupled IF port can be used as a phase detector.

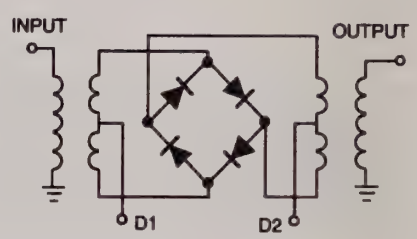

Figure 29 — A diode-ring mixer as phase modulator.

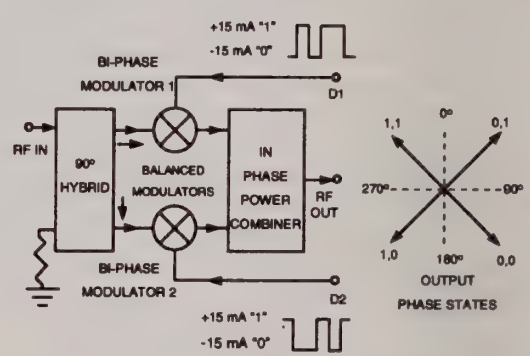

Figure 30 — Two biphase modulators form the basis for a QPSK modulator.

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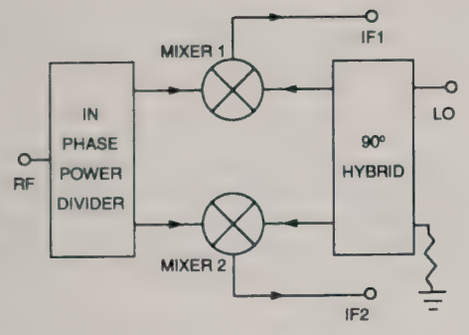

Figure 31 — Quadrature mixer.

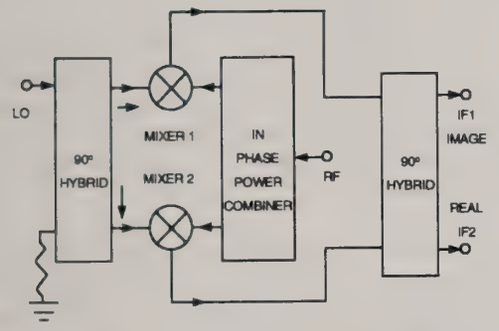

Figure 32 — An image-reject mixer uses phasing to differentiate between its LO+IF and LO–RF IF outputs.

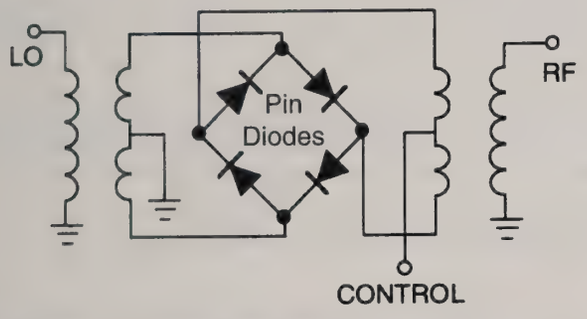

Figure 33 — A diode DBM can be used as a dc-controlled attenuator if PIN diodes are used instead of Schottky devices in its ring.

2-2-3 Quadrature phase-shift keying (QPSK) modulator. A typical QPSK Modulator consists of two biphase modulators, a 90° divider, and a 0° power combiner as shown. Data inputs at the control ports will cause the carrier to shift between 0, 90, 180 and 270° as shown in Figure 30.

2-2-4 Quadrature IF mixer. A quadrature IF Mixer produces two IF outputs in phase quadrature. Its basic structure consists of two double balanced mixers, a 90° splitter and 0° splitter. The basic block diagram is shown in Figure 31.

2-2-5 Image-reject mixer. The image-reject mixer consists of a basic quadrature IF mixer with an additional 90° hybrid at the IF ports as shown in Figure 32. The primary function is to differentiate between the real signal and the image signal. This type of device is especially useful in applications where the desired RF signal and image are so close in frequency that rejecting the image with filtering is not practical.

2-2-6 Diode attenuator/switch. A ring of PIN diodes can be used as electronic attenuators by applying variable forward bias to the diodes (Figure 33). Maximum attenuation is achieved when the current at the control port is zero. The maximum attenuation is the isolation between the input and output port. Minimum attenuation (insertion loss) is achieved when the IF port current is 20 mA.

2-2-7 Single-sideband (SSB) or in-phase/quadrature (I/Q) modulator. SSB or I/Q modulators are useful in discriminating and removing the lower sideband (LSB) or upper sideband (USB) generated during frequency conversion, especially when the sidebands are very close in frequency and attenuation of one of the sidebands cannot be achieved with filtering. This is the case with audio and video modulation, where signals from dc to 10 MHz must be converted to a higher frequency that is appropriate for transmission. In such cases, both sidebands will be very close in frequency to the carrier frequency. With an I/Q modulator, one of the sidebands is easily cancelled or attenuated along with its carrier.

Attenuation of the carrier has been the most troublesome aspect in the design of passive I/Q modulators. Isolation between the local-oscillator (LO) port and the RF port of the mixers, which is the main parameter in determining carrier rejection, is usually insufficient at frequencies above 200 MHz.

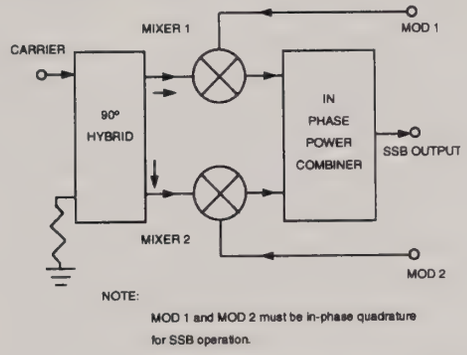

Figure 34 — An SSB modulator matches two high-frequency mixers, a 90° hybrid, and an in-phase power combiner to produce an SSB output signal.

I/Q modulator designs have basically comprised two double-balanced mixers (Figure 34). The mixers are fed at the LO ports by a carrier phase-shifted through a 90°. hybrid. Thus, the carrier signal's relative phase is 0° to one mixer and 90° to the other mixer. Modulation signals are fed externally in phase quadrature to the two mixers' IF ports. The mixers' modulated output signals are combined through a two-way, in-phase power divider/combiner.

The circuit forms a phase-cancellation network to one of the sidebands and a phase-addition network to the other sideband. The carrier is somewhat attenuated and is directly dependent on the inherent LO-to-RF isolation of the mixers and the modulating signal level. In industry-standard I/Q modulators, USB suppression results when the first modulation port (MOD 1) is fed with a signal that is 90° in advance of the signal feeding the second modulation port (MOD 2). Opposite phasing can be arranged by changing the internal phase polarity of the mixers or by interchanging the 90° hybrid output ports to the LO ports of the mixers.

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The phase and amplitude imbalances between the various components used in the manufacturing of the I/Q modulators must be tightly maintained for optimum SSB rejection. Matching of the two mixers for conversion loss and insertion phase is extremely critical, since differences in these parameters will add to amplitude- and phase-imbalance errors. The 90° hybrid in the LO port must be in nearly perfect phase quadrature.

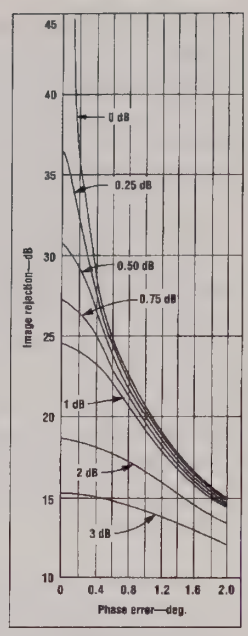

Figure 35 — The level of SSB rejection improves as the phase and amplitude imbalance performance of an SSB modulator improves.

Phase- and amplitude-imbalance errors adversely affect sideband suppression (Figure 35). In most cases, a typical passive I/Q modulator operates with a carrier input level of +10 dBm, which is required to drive the diodes in the mixers to operate in the linear range. The dynamic range of these mixers can be significantly improved by using diodes with a higher barrier height. The LO signal in this case must be increased in order to drive these diodes into conduction in their linear range. Carrier rejection is also a problem when designing an SSB modulator, since only a few decibels of suppression can be achieved in standard high-frequency models. The major contributor to carrier suppression is the inherent LO-to-RF isolation through the mixers. Unfortunately, this isolation is usually poor at cellular frequencies (800 to 1000 MHz), where at least 25 dB of carrier rejection is necessary. In some cases, designers feed a small amount of dc into the IF ports to control the carrier rejection, but this complicates the driver circuitry and calls for temperature compensation when operating at different temperatures. As an example, an SSB modulator is assumed to operate with +10-dBm LO drive with each modulating signal at –10 dBm and in phase quadrature to each other when applied to the modulating ports (MOD 1 and MOD 2). The result will be a modulated signal at –16 dBm, assuming 6-dB conversion loss. For 20-dB carrier rejection with respect to the desired modulated signal, the carrier must be at –36 dBm, which translates to LO-to-RF isolation of 46 dB.

For 20-dB carrier rejection with respect to the desired modulated signal, the carrier leakage must be at –36 dBm, which translates to LO-to-RF isolation of 46 dB.

By employing a subharmonic approach, the performance of SSB modulators can be extended beyond the limits of conventional designs. The approach is based on the use of subharmonic mixers in place of Double Balanced-frequency mixers and is applicable from about 140 to 3000 MHz. Matched antiparallel diode pairs used in single-ended or single-balanced mixer configurations cancel even-order intermodulation products (such as $2f_{LO} \times 2f_{RF}$, $3f_{LO} \times 3f_{RF}$, etc.) at all ports.

Single-ended mixers lack the port-to-port isolation needed for SSB modulator applications. Odd-order products of the RF and LO frequencies (even f_{LO} × odd f_{RF}) and (odd f_{LO} × even f_{RF}) appear on all ports, requiring extensive filtering for satisfactory performance. For a single-balanced mixer, even harmonics of the LO combining with odd harmonics of the RF appear at the IF port, whereas odd harmonics of the LO combining with even harmonics of the RF appear at the RF and IF ports. This assumes that a balanced transformer is placed at the LO port, which is a logical choice due to the fact that the highest level signal appears at the LO port. Since the desired odd-order IF products appear at both the RF and IF ports, a need arises for a diplexing network to isolate the RF and IF signals.

The subharmonic modulator design provides a unique way to isolate the RF and IF signals. A single-balanced harmonic mixer offers good LO-to-RF and LO-to-IF isolation but poor RF-to-IF isolation. Fortunately, harmonically related signals are spaced well apart in the frequency spectrum, simplifying filtering of harmonically related signals.

Harmonic mixing also works well with low LO power levels, with somewhat lower 1-dB compression on the RF port than with fundamental-frequency mixing. The ability to operate with LO frequencies that are a fraction of the carrier frequency (1/2, 1/4, 1/6, etc.) significantly reduces the cost of an LO source, especially at higher frequencies. Also, using lower-frequency LO sources helps avoid the signal-leakage problems inherent with higher-frequency LO sources. Minimizing signal leakage, especially at higher frequencies, becomes expensive and bulky. Subharmonic mixing offers several advantages:

- The technique offers the ability to operate at LO frequencies that are 1/2, 1/4, or 1/6 of the carrier frequency. For example, for an IF of 100 MHz at an RF of 2 GHz, the LO can be (2000±100) ÷ 2 = 950 or 1050 MHz.
- The LO's even harmonics are strongly attenuated.
- The filtering requirements for fundamental frequency and odd harmonic signals of the LO are not critical.
- The cost of generating the LO is reduced due to the fact that the LO frequency need only be a fraction of the carrier frequency.

As an example of the performance improvements possible with the subharmonic mixers, units were evaluated at both cellular (935- to 960-MHz) and PCN/PCS (1.8- to 1.9-GHz) bands. For a conventional SSB modulator at 1.9 GHz fed with +10 dBm modulation signals, carrier rejection is barely 10 dB (36).

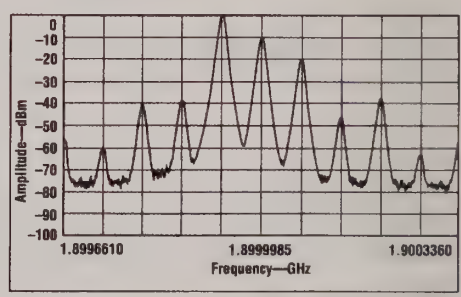

Figure 36 — This plot of carrier and sideband rejection was measured for a conventional SSB modulator operating at 1.9 GHz.

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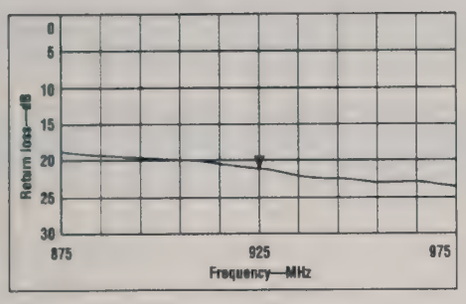

Figures 37 — The SSB modulator's return loss as measured at the local-oscillator (LO) port

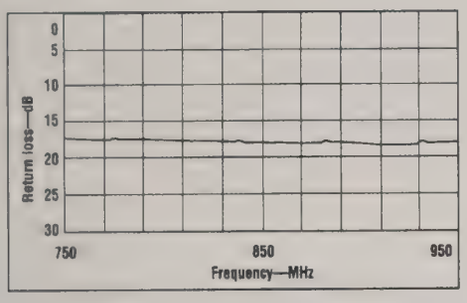

Figure 38 — The novel harmonic SSB modulator's return loss as measured at the RF port.

Sideband rejection can be improved by tuning, but the carrier rejection is controlled by the LO-to-RF isolation of the double-balanced mixers. Conventional double-balanced mixers with high isolation at cellular and PCN bands are very expensive and large when special techniques are used to improve LO to-RF isolation. In contrast, the subharmonic nature of the new approach allows the use of lower-frequency, less-expensive components in the modulators' construction.

The subharmonic modulators offer an improvement of more than 15 dB in carrier suppression compared to the conventional approach.

The measured return loss at the LO and RF ports is better than 18 dB (Figures 37 and 38). Measurements made on a cellular-band SSB modulator reveal carrier rejection on the order of 40 dB. Typical insertion loss is 7 dB while sideband rejection is 30 dB (Figure 39).

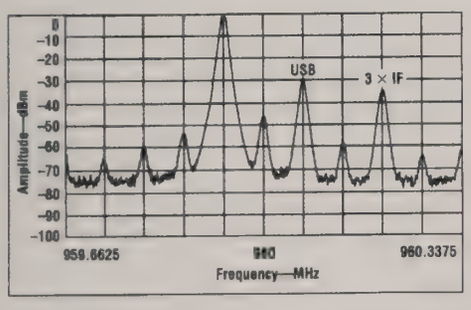

Figure 39 — This plot of carrier and sideband rejection as measured for the novel harmonic SSB modulator operating at cellular frequencies.

By the virtue of harmonic mixing, even-order mixing products are attenuated by about 30 dB with respect to the desired modulated output signal. The fundamental-frequency feedthrough into the output port is approximately 5 dB lower than the desired modulated signal, whereas the fourth harmonic mixing with the modulating signal is approximately 10 dB lower. Typical loss for fourth-harmonic mixing is 17 to 19 dB while maintaining 30 dB of carrier rejection.

Since harmonically-related products are well-spaced in frequency, filtering undesired signals is relatively inexpensive using standard octave-bandwidth filters. Low-cost commercial bandpass filters typically offer better than 40 to 50 dB attenuation of unwanted harmonic signals. Constant-impedance bandpass filters offering good impedance match at desired stopbands can also be used in cases where harmonically related products require impedance termination within a system.

The subharmonic modulator design is easily applied at custom frequencies. Conversion of an SSB modulator with output frequency corresponding to twice the LO frequency to one with output corresponding to four times the LO frequency requires only one component change, in the form of a signal-combining network at the modulator's output. Although the conversion loss of the fourth-harmonic LO component mixing with the modulating signal is in the vicinity of 18 dB, the cost of generating the LO is drastically reduced with the subharmonic modulator. In spite of higher signal loss, the carrier rejection is still at least 30 dB at the fourth harmonic, and harmonically related products can be eliminated with an inexpensive filter.

2-2-8 Triple-balanced mixer. Two diode rings can be combined to form a double double-balanced mixer, or triple-balanced mixer (TBM), as shown in Figure 40. Triple-balanced mixers achieve greater higher dynamic range and interport isolation than double-balanced designs especially above 1 GHz at the expense of LO power and increased complexity and size. The conversion loss of Triple Balanced mixers increases by approximately 6 dB as the IF frequency is lowered below the sampling LO/RF frequency towards DC.

Figure 41 shows the circuit's interport isolation with the circuit configured in a less than ideally balanced form, with small variations in transformer-winding inductance and diode parameters introduced for more realistic modeling. Note that the mixer's interport isolation generally less sloped with frequency, when compared with the DBM (Figure 42).

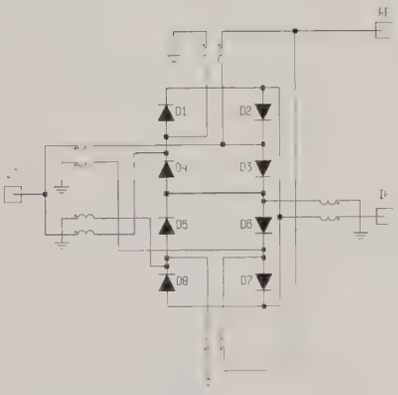

Figure 40—A triple-balanced diode mixer. A limitation of this configuration is that the internal dc common connections associated with its RF and LO transformers disallow usable IF response down to dc.

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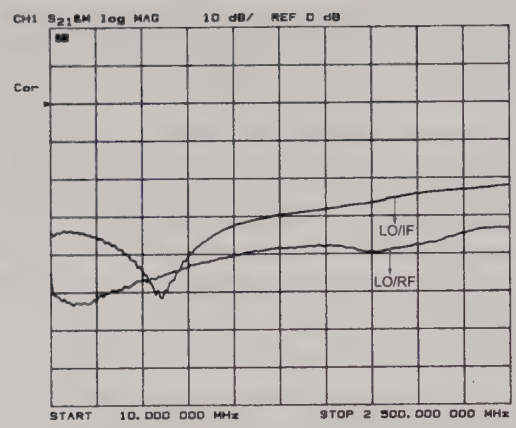


Figure 41—The triple-balanced mixer offers improved high-frequency isolation over a standard DBM.

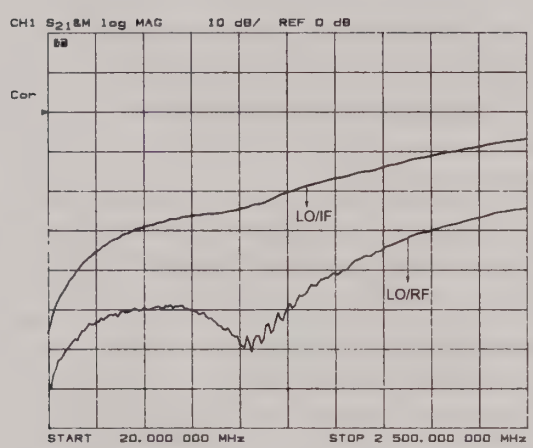


Figure 42—The Double-balanced mixer isolation for a DBM.

MIXERS
SUB-HARMONIC

LO = +7 dBm

EXCELLENT L.O. REJECTION

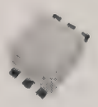
EVEN-HARMONIC MIXERS

An even-harmonic mixer will, by its inherent design, convert the fundamental input L.O. frequency into its even harmonics (m=2,4 or 8 etc.). These even harmonics will mix with the fundamental R.F. frequency to basically produce m L.O. ± R. F. mixing results. Synergy specifies the 2 L.O. and 4 L.O. mixing products, as the higher L.O. even harmonics result in much higher conversion losses. The best conversion loss is achieved at the 2 L.O. x 1 R.F. mixing condition.

These models allow for lower frequency local oscillators to be used, therefore reducing costs.

SURFACE MOUNT

134S

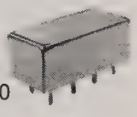
159 

FREQUENCY RANGE (MHz)			CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)	LO-IF ISOLATION (dB)	OUTLINE DRAWING	PACKAGE	MODEL
RF	LO	IF	2LO-RF TYP/MAX	4LO-RF TYP/MAX	TYP/MIN	TYP/MIN			
280-800	140-400	DC-100	11.5/13.5	17.0/26	45/33	30/22	159	1	**XLD-K1**
280-800	140-400	DC-100	11.5/13.5	17.0/26	45/33	30/22	134S	1	**XMZ-K1**
500-1800	250-900	DC-200	11.5/14.5	17.0/26	40/30	25/18	159	1	**XLD-K2**
500-1800	250-900	DC-200	11.5/14.5	17.0/26	40/30	25/18	134S	1	**XMZ-K2**
800-2400	400-1200	DC-300	12.5/16.5	18.0/27	30/25	25/16	159	1	**XLD-K3**
800-2400	400-1200	DC-300	12.5/16.5	18.0/27	30/25	25/16	134S	1	**XMZ-K3**

THROUGH HOLE

106

108

120 

FREQUENCY RANGE (MHz)			CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)	LO-IF ISOLATION (dB)	OUTLINE DRAWING	PACKAGE	MODEL
RF	LO	IF	2LO-RF TYP/MAX	4LO-RF TYP/MAX	TYP/MIN	TYP/MIN			
900-2400	450-1200	DC-300	12.5/16.5	18.0/24	30/25	25/16	120	2	**CXP-237**
900-2400	450-1200	DC-300	12.5/16.5	18.0/24	30/25	25/16	106	3	**CXP-337**
900-2400	450-1200	DC-300	12.5/16.5	18.0/24	30/25	25/16	108	2	**CXP-437**

NOTES:

1. 1dB Compression Point = -7 dBm (Typ)
2. IP3 (Input) = +4 dBm (Typ)

PIN-OUT TABLE

	RF	LO	IF	GND
#1	4	1	5	2, 3,6
#2	1	2	3	2,5,67
#3	1	2	4	3

GND = Ground externally

For pin location and package outline drawings, see back pages.

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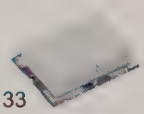
SYNERGY MICROWAVE CORPORATION

STARVED L.O. MIXERS
DOUBLE-BALANCED

LO = +1 dBm

ULTRA-LOW POWER CONSUMPTION

Surface Mount


133

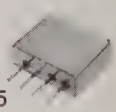
134

134S

159

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
5-500	DC-500	6.5/7.5	7/8.5	70/45	60/40	50/25	65/40	50/35	40/20	134	1	**SRD-KA**
5-500	DC-500	6.5/7.5	7/8.5	70/45	60/40	50/25	65/40	50/35	40/20	159	1	**SRL-KA**
5-500	DC-500	6.5/7.5	7/8.5	70/45	60/40	50/25	65/40	50/35	40/20	134S	1	**SRZ-KA**
5-500	DC-500	6.5/7.5	7/8.5	70/45	60/40	50/25	65/40	50/35	40/20	133	2	**SRD-CA**
800-1000	DC-200	--/--	7/8.5	--/--	35/25	--/--	--/--	30/20	--/--	134	1	**SRD-KB***
800-1000	DC-200	--/--	7/8.5	--/--	35/25	--/--	--/--	30/20	--/--	159	1	**SRL-KB***
800-1000	DC-200	--/--	7/8.5	--/--	35/25	--/--	--/--	30/20	--/--	134S	1	**SRZ-KB***
800-1000	DC-200	--/--	7/8.5	--/--	35/25	--/--	--/--	30/20	--/--	133	2	**SRD-CB***
1500-2500	DC-1000	6/8.5	7.5/10	27/20	--/--	27/20	15/10	--/--	13/8	134	1	**SRD-KD****
1500-2500	DC-1000	6/8.5	7.5/10	27/20	--/--	27/20	15/10	--/--	13/8	159	1	**SRL-KD****
1500-2500	DC-1000	6/8.5	7.5/10	27/20	--/--	27/20	15/10	--/--	13/8	134S	1	**SRZ-KD****
1500-2500	DC-1000	6/8.5	7.5/10	27/20	--/--	27/20	15/10	--/--	13/8	133	2	**SRD-CD****

Through Hole


105

106

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-500	DC-500	6.5/7.5	7/8.5	70/45	60/35	50/25	65/40	50/30	40/20	105	3	**CRP-301**
800-1000	DC-200	--/--	7/8.5	--/--	35/25	--/--	--/--	30/20	--/--	106	3	**CRP-334***
1500-2500	DC-1000	6/8.5	7.5/10	27/20	--/--	27/20	15/10	--/--	13/8	106	3	**CRP-337****

XMB = 2LF to HF/2
FULL BAND = LF to HF
LB = LF to 10LF
MB =10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2, 3,6	--
#2	1	2	3	4,5,6	--
#3	1	4	2	3	3

GND = Ground externally
For pin location and package outline drawings, see back pages.

NOTES:

1. 1dB Compression Point = -4 dBm (Min)
2. IP3 (Input) = +7 dBm (Typ)

* MB = 800-1000 MHz

** XMB=1700-2100 MHz; LB = 1500-2000 MHz; UB = 2000-2500 MHz

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MIXERS
DOUBLE-BALANCED

SOURCE-LINE (LOW COST)

102

106

116

120

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO DRIVE	1dB COMP.	IP3 (INPUT)	ISOLATION L-R (dB)			ISOLATION L-I (dB)			PACKAGE	PIN OUT	MODEL
		XMB	FULL BAND				LB	MB	UB	LB	MB	UB			
RF/LO	IF	TYP/MAX	TYP/MAX	(dBm)	(dBm) TYP	(dBm) TYP	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN			
1-500	DC-500	5.5/7	6.5/8	+7	0	+13	60/45	45/35	40/25	45/35	40/25	30/20	120	1	**S-1****
1-500	DC-500	5.5/7	6.5/8	+17	+6	+21	60/45	45/35	40/25	45/35	40/25	30/20	120	1	**S-1H****
1-500	DC-500	6/7.5	7/8.5	+7	0	+13	60/45	45/35	40/25	45/35	40/25	30/20	120	1	**S-2****
.5-500	DC-500	5.5/7	6.5/8.5	+7	0	+13	50/45	45/30	35/25	45/35	40/25	30/20	102	2	**S-3**
.5-500	DC-500	5.5/7	6.5/8.5	+7	0	+13	50/45	45/30	35/25	45/35	40/25	30/20	102	3	**S-3Z**
.5-500	DC-500	5.5/7.5	6.5/8.5	+17	9	+22	55/45	45/30	45/25	45/35	40/30	30/20	102	2	**S-3H**
1-600	DC-600	5.5/7	6/8.5	+7	0	+13	50/30	35/25	30/20	45/35	30/20	25/15	116	5	**S-5****
1-1000	DC-1000	7/8	8/9.8	+7	0	+13	60/40	35/18	26/16	50/30	25/17	15/10	116	5	**S-5E****
.5-800	DC-800	5.5/7	6/8.5	+17	+9	+22	70/40	45/35	40/30	60/40	40/30	30/25	102	7	**S-7H**
10-1000	5-600	6/7.5	7/8	+7	0	+9	50/40	40/30	30/20	50/45	40/35	35/25	120	4	**S-4****
10-1000	5-600	6/7.5	7/8	+7	0	+9	50/40	40/30	30/20	50/45	40/35	35/25	120	1	**S-4A****
1-1000	DC-1000	6/7.5	7/8.5	+7	0	+13	50/45	40/25	30/25	45/40	35/25	25/20	106	6	**S-6**
1-1000	DC-1000	6/7.5	7/8.5	+7	0	+13	50/45	40/25	30/25	45/40	35/25	25/20	106	6	**S-6P** ■
.5-500	DC-500	5.5/7	6.5/8.5	+7	+1	+13	50/45	45/30	35/25	45/35	40/25	30/20	102	2	**S-8**
2-600	DC-600	5.5/7	7/8	+7	+1	+13	60/50	42/30	37/25	60/45	47/30	36/22	106	6	**TOP-1**
50-1000	DC-1000	6/7	7.8/9	+7	+1	+13	58/45	45/30	38/25	50/35	40/20	35/18	106	6	**TOP-2**
0.15-400	DC-400	5/7	5.5/8	+7	+1	+13	60/50	46/30	35/25	60/40	47/25	35/20	106	6	**TOP-3**
20-1500	DC-1000	7.5/8	8.5/9	+7	+1	+13	54/40	42/30	39/25	40/25	32/18	23/8	106	6	**TOP-5**

NOTES:

■ Phase Detection, Polarity Positive
** Non - Hermetic

XMB = 2LF to HF/2
FULL BAND = LF to HF
LB = LF to 10LF
MB =10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	1	8	*3,4	2,5,6,7	--
#2	1	8	*3,4	2,5,6,7	2
#3	7	1	*3,4	2,5,6,8	2,5,6
#4	*3,4	8	1	2,5,6,7	2,5,6,7
#5	4	1	5	2,3,6	--
#6	1	4	2	3	3
#7	1	8	*3,4	2,5,6,7	2,5,6,7

* Pins must be connected together externally
GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

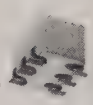
MIXERS
DOUBLE-BALANCED

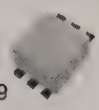
LO = +7 dBm

LOW POWER CONSUMPTION

SURFACE MOUNT

134

134S 

159 

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-500	DC-500	5.5/7	6/8.5	55/50	35/25	30/20	55/45	30/25	25/20	159	1	**SLD-K1***
0.5-500	DC-500	5.5/7	6/8.5	55/50	35/25	30/20	55/45	30/25	25/20	134	1	**SMD-K1***
0.5-500	DC-500	5.5/7	6/8.5	55/50	35/25	30/20	55/45	30/25	25/20	134S	1	**SMZ-K1***
2-750	DC-750	6/7.5	6/8.5	70/45	45/28	38/22	60/45	40/25	30/20	159	1	**SLD-K1W***
2-750	DC-750	6/7.5	6/8.5	70/45	45/28	38/22	60/45	40/25	30/20	134	1	**SMD-K1W***
2-750	DC-750	6/7.5	6/8.5	70/45	45/28	38/22	60/45	40/25	30/20	134S	1	**SMZ-K1W***
5-1000	DC-1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	159	1	**SLD-K2***
5-1000	DC-1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	134	1	**SMD-K2***
5-1000	DC-1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	134S	1	**SMZ-K2***
5-1000	DC-1000	6.5/8	7/9	60/40	40/30	33/22	55/30	40/22	30/20	159	1	**SLD-K2D***
5-1000	DC-1000	6.5/8	7/9	60/40	40/30	33/22	55/30	40/22	30/20	134	1	**SMD-K2D***
5-1000	DC-1000	6.5/8	7/9	60/40	40/30	33/22	55/30	40/22	30/20	134S	1	**SMZ-K2D***
5-1200	DC-500	6.8/8	8/9	60/40	60/30	37/22	60/40	48/20	31/15	134	1	**SMZ-K2W***
10-1000	10-750	6.5/8	8/9.5	55/40	40/30	30/25	55/30	35/25	30/22	159	1	**SLD-K2U***
10-1000	10-750	6.5/8	8/9.5	55/40	40/30	30/25	55/30	35/25	30/22	134	1	**SMD-K2U***
10-1000	10-750	6.5/8	8/9.5	55/40	40/30	30/25	55/30	35/25	30/22	134S	1	**SMZ-K2U***
5-1500	DC-1000	6.5/7.5	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	159	1	**SLD-K3***
5-1500	DC-1000	6.5/7.5	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	134	1	**SMD-K3***
5-1500	DC-1000	6.5/7.5	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	134S	1	**SMZ -K3***

NOTES:

* Phase Detection, Polarity Positive
1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND
#1	4	1	5	2,3,6

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

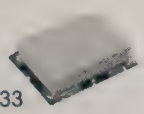
MIXERS

DOUBLE-BALANCED

LO = +7 dBm

LOW POWER CONSUMPTION

106B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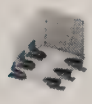
134


134S

154

156

159

Surface Mount

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
5-1900	5-1000	7.2/8.2	8.5/9.8	58/45	35/22	30/20	56/45	37/20	27/20	159	2	**SLD-K11X***
5-1900	5-1000	7.2/8.2	8.5/9.8	58/45	35/22	30/20	56/45	37/20	27/20	134	2	**SMD-K11X***
5-1900	5-1000	7.2/8.2	8.5/9.8	58/45	35/22	30/20	56/45	37/20	27/20	134S	2	**SMZ-K11X***
1500-1900	40-400	--/--	7.8/9	25/17	25/17	25/17	23/15	23/15	23/15	159	2	**SLD-K11A***
1500-1900	40-400	--/--	7.8/9	25/17	25/17	25/17	23/15	23/15	23/15	134	2	**SMD-K11A***
1500-1900	40-400	--/--	7.8/9	25/17	25/17	25/17	23/15	23/15	23/15	134S	2	**SMZ-K11A***
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	159	1	**SLD-K4**
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134	1	**SMD-K4**
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134S	1	**SMZ-K4**
200-3000	DC-1000	6.5/9	9/9.8	27/17	27/17	27/17	20/7	20/7	20/7	159	1	**SLD-K6***
200-3000	DC-1000	6.5/9	9/9.8	27/17	27/17	27/17	20/7	20/7	20/7	134	1	**SMD-K6***
200-3000	DC-1000	6.5/9	9/9.8	27/17	27/17	27/17	20/7	20/7	20/7	134S	1	**SMZ-K6***
1-1000	DC-1000	6.5/7.5	7.5/9.5	70/45	45/30	40/25	60/40	35/23	30/15	133	3	**SMD-C1**
1-500	DC-500	6/7	6.5/8	60/40	45/35	40/30	50/40	45/35	40/25	133	3	**SMD-C1X**
20-1500	DC-1500	7/8.5	8.5/9	50/35	40/25	20/10	40/25	30/18	15/8	133	3	**SMD-C2**
20-2500	20-600	8/9	9/10.5	45/30	30/23	30/15	40/20	25/15	25/12	133	3	**SMD-C3**
15-2000	DC-1500	7/9	8/10.5	70/30	30/20	20/13	50/30	20/15	20/10	133	3	**SMD-C4♦**
1-500	DC-500	5.5/7	6.5/8.5	60/45	45/35	40/25	45/35	40/25	30/20	154	4	**SSM-1**
5-1000	DC-1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	154	4	**SSM-2**
1-600	DC-600	5.5/7	6/8.5	50/30	35/25	30/20	45/35	30/20	20/15	156	1	**SM-5**
5-1000	DC-1000	6.5/8	7/9	60/40	35/18	26/16	50/30	25/17	15/10	156	1	**SM-5E**
2-600	DC-600	5.5/7	7/8	60/50	42/30	37/25	60/45	47/30	36/22	106B	5	**TOP-1Z**
50-1000	DC-1000	6/7	7.8/9	58/45	45/30	38/25	50/35	40/20	35/18	106B	5	**TOP-2Z**
20-1500	DC-1000	7.5/8	8.5/9	54/40	42/30	39/25	40/25	32/18	23/8	106B	5	**TOP-5Z**

NOTES:

1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

* Phase Detection, Polarity Positive

♦ Specifications apply when RF > LO

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2,3,6	–
#2	5	1	4	2,3,6	–
#3	1	2	3	All Other	–
#4	1	8	**3,4	2,5,6,7	–
#5	1	4	2	3	3

GND = Ground externally
** Connect pins 3,4 together externally
For pin location and package outline drawings, see back pages.

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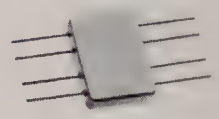
SYNERGY® MICROWAVE CORPORATION

MIXERS
DOUBLE-BALANCED

LO = +7 dBm

LOW POWER CONSUMPTION



FLAT-PACK

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			Package	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	101	1	**CLF-102**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	101	1	**CLF-112**
0.04-400	DC-400	5.3/7	6/8	60/50	50/35	35/25	45/40	35/25	25/20	101	1	**CLF-1R3**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	101	1	**CLF-101**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	101	1	**CLF-103**
10-1500	DC-1500	6/7	7/10	55/40	45/35	30/20	50/40	40/25	20/12	101	1	**CLF-1A5**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	101	1	**CLF-111**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	101	1	**CLF-109**
700-2000	DC-300	--/--	6/8	35/20	35/20	35/20	20/12	20/12	20/12	101	1	**CLF-1F6**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	101	1	**CLF-104**

NOTES:

1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND
#1	1	4	5	All Other

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

MIXERS

DOUBLE-BALANCED

LO = +7 dBm

LOW POWER CONSUMPTION

THROUGH HOLE (RELAY)

102

103

120

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.0005-10	DC-10	6.5/7.5	7/8.5	60/50	50/40	45/35	60/50	50/40	45/35	102	1	**CLP-2D1**
0.003-100	DC-100	5.5/7.5	6.5/8.5	60/50	45/30	35/25	60/45	40/25	30/20	102	1	**CLP-2C1**
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	102	2	**CLP-202**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	103	2	**CLP-212**
0.025-200	DC-200	5.5/7.5	6.5/8.5	60/50	45/35	35/25	45/35	40/30	30/20	102	2	**CLP-2C2**
0.025-200	DC-200	5.5/7.5	6.5/8.5	55/50	45/30	35/25	45/35	40/30	30/20	120	1	**CLP-2B2****
0.1-500	DC-500	6/7	7/8.0	65/40	60/40	50/30	45/30	50/35	35/20	103	2	**CLP-201**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	103	3	**CLP-203**
1-750	DC-750	5.5/7.5	6.5/8.5	50/45	45/30	35/25	45/30	40/25	30/20	102	3	**CLP-2D4**
1-1000	0.5-500	5.5/7.5	6.5/8.5	45/30	35/20	30/20	45/30	30/20	30/20	102	4	**CLP-2F4**
5-1000	DC-1000	6/7	6.5/8.5	60/50	35/30	30/25	50/45	30/25	25/20	102	3	**CLP-2G4**
10-1000	DC-500	6.5/7.5	7/9	50/40	35/25	25/20	40/25	25/18	19/15	120	5	**CLP-2C4****
5-1250	0.5-500	5.5/7.5	6.5/8.5	50/40	40/20	30/20	50/40	40/20	30/20	102	4	**CLP-2D5**
5-1500	10-600	7/8	7.5/8.5	50/45	35/30	30/20	45/40	30/25	25/15	120	6	**CLP-2E5**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	102	3	**CLP-211**
5-2000	10-600	7/8.5	7.5/9	50/45	35/25	30/20	45/40	30/20	25/15	120	6	**CLP-2A6**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	120	6	**CLP-209**
100-2000	DC-600	6/9.5	7/9.5	37/20	37/20	37/20	30/20	30/20	30/20	120	6	**CLP-2C6**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	120	5	**CLP-204**

NOTES:

1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

** Non-hermetic

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN
#1	*3,4	8	1	2,5,6,7	2,5,6,7	--
#2	1	8	*3,4	2,5,6,7	2	--
#3	1	8	*3,4	2,5,6,7	2,5,6,7	--
#4	*3,4	8	1	2,5,6,7	2,5,6,7	--
#5	8	1	3	2,5,6,7	2,5,6,7	4
#6	1	8	3	2,5,6,7	2,5,6,7	4

GND = Ground externally
* Connect pins 3,4 together externally
For pin location and package outline drawings, see back pages.

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MIXERS

DOUBLE-BALANCED

LOW POWER CONSUMPTION

LO = +7 dBm

THROUGH HOLE (MINI-RELAY)

105

106

107

108

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
		XMB	FULL BAND	LB	MB	UB	LB	MB	UB			
RF/LO	IF	TYP/MAX	TYP/MAX	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	105	1	**CLP-302**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	105	1	**CLP-312**
0.04-400	DC-400	5.5/7	6/8	60/50	50/35	35/25	55/40	45/30	35/25	106	1	**CLP-3P3**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	106	1	**CLP-301**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	106	1	**CLP-303**
5-1250	DC-1250	6/7.5	7.5/8.5	50/45	40/30	30/25	45/40	35/25	25/20	106	1	**CLP-3M5**
5-1500	DC-1000	6.5/8.5	8/9.5	60/45	35/25	30/25	60/40	35/15	25/14	106	1	**CLP-3L5**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	106	1	**CLP-311**
1-2000	5-600	7/8.5	7.5/9	50/45	35/25	25/10	45/40	27/20	25/20	105	1	**CLP-3D6**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	105	1	**CLP-309**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	106	1	**CLP-304**
1000-3500	DC-1000	--/--	7.5/9.5	30/17	30/17	30/17	20/8	20/8	20/8	106	1	**CLP-307**
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	107	2	**CLP-402**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	107	2	**CLP-412**
0.1-500	DC-500	5.5/7	6.5/8.5	60/50	50/35	35/30	50/40	45/30	30/20	107	2	**CLP-4A3**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	108	2	**CLP-401**
1-600	DC-600	6/7.5	6.5/8.5	60/45	45/35	35/25	55/45	40/30	35/25	108	2	**CLP-4N4**
1-600	DC-600	5.5/7	6.5/8.5	55/45	45/30	35/20	50/40	40/25	30/20	107	2	**CLP-4A4**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	108	3	**CLP-403**
1-1000	DC-1000	6/7.5	7/9.5	55/45	40/25	35/20	50/40	40/25	30/25	107	3	**CLP-4B4**
1-1000	DC-1000	6/7.5	7/10	55/45	40/20	35/18	50/40	40/20	25/18	108	2	**CLP-4Q4**
5-1250	0.5-1000	6.5/8.5	6.5/8.5	55/40	35/25	30/20	50/40	35/25	30/20	107	4	**CLP-4B5**
5-1500	0.5-1000	6.5/7.5	6.5/8.5	55/40	35/25	30/20	50/40	35/25	30/20	107	4	**CLP-4C5**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	107	3	**CLP-411**

NOTES:

1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	1	4	2	3	3
#2	1	8	*3,4	2,5,6,7	2
#3	1	8	*3,4	2,5,6,7	2,5,6,7
#4	*3,4	8	1	2,5,6,7	2,5,6,7

* Pins must be connected together externally
GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

MIXERS

DOUBLE-BALANCED

LO = +7 dBm

LOW POWER CONSUMPTION

PLUG-IN (TO-CAN)

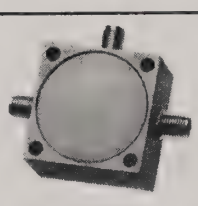
104

122

126

127

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	104	1	CLP-502
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	104	1	CLP-512
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	104	1	CLP-501
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	104	1	CLP-503
800-2500	DC-400	--/--	6.6/8.5	30/20	30/20	30/20	20/10	20/10	20/10	104	1	CLP-504
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	122	2	CLP-612
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	122	2	CLP-603
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	122	2	CLP-611
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	122	2	CLP-609
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	122	2	CLP-604
0.2-200	DC-200	5.5/6	5.5/6	45/35	40/30	35/25	45/35	40/30	35/25	127	3	CLP-8T3
5-500	DC-500	5.7/6.5	6.5/7	40/35	40/30	35/25	35/30	35/30	30/25	127	3	CLP-8S3
1-1000	DC-1000	6.5/7.5	7/8.5	50/40	40/25	30/20	45/40	35/25	25/20	126	4	CLP-8A4



COAXIAL

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	110	5	CLK-702*
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	110	5	CLK-712*
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	110	5	CLK-701*
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	110	5	CLK-703*
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	110	5	CLK-711S
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	110	5	CLK-709S
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	110	5	CLK-704S
800-4200	DC-1000	--/--	6.5/10	25/13	25/13	25/13	20/10	20/10	20/10	110	5	CLK-215S

NOTES:
1. 1dB Compression Point = +1 dBm (Typ)
2. IP3 (Input) = +13 dBm (Typ)

* Connector style: "B" = BNC, "T" = TNC, N" = Type N, "S" = SMA

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	2	5	11	All Others	All Others
#2	1	3	2	4	--
#3	4,1	2	3	5	5
#4	4	2	3	1	1
#5	1	3	2	--	--

GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS
DOUBLE-BALANCED

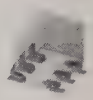
LO = +10 dBm

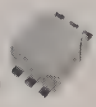
IMPROVED DYNAMIC RANGE

SURFACE MOUNT

106B

134

134S 

159 

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
		XMB	FULL BAND	LB	MB	UB	LB	MB	UB			
RF/LO	IF	TYP/MAX	TYP/MAX	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN			
0.5 - 500	DC - 500	5.4/7	6/8	58/45	44/25	30/20	55/40	40/25	28/17	159	1	**SLD-K1L***
0.5 - 500	DC - 500	5.4/7	6/8	58/45	44/25	30/20	55/40	40/25	28/17	134	1	**SMD-K1L***
0.5 - 500	DC - 500	5.4/7	6/8	58/45	44/25	30/20	55/40	40/25	28/17	134S	1	**SMZ-K1L***
5 - 1000	DC - 1000	6.4/8	7/9.5	58/40	39/20	22/16	52/30	30/17	18/11	159	1	**SLD-K2L***
5 - 1000	DC - 1000	6.4/8	7/9.5	58/40	39/20	22/16	52/30	30/17	18/11	134	1	**SMD-K2L***
5 - 1000	DC - 1000	6.4/8	7/9.5	58/40	39/20	22/16	52/30	30/17	18/11	134S	1	**SMZ-K2L***
5 - 1500	DC - 900	6.5/8	7.6/9.8	58/35	38/20	25/18	56/30	38/14	17/6	159	1	**SLD-K3L***
5 - 1500	DC - 900	6.5/8	7.6/9.8	58/35	38/20	25/18	56/30	38/14	17/6	134	1	**SMD-K3L***
5 - 1500	DC - 900	6.5/8	7.6/9.8	58/35	38/20	25/18	56/30	38/14	17/6	134S	1	**SMZ -K3L***
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	159	1	**SLD-K4L**
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134	1	**SMD-K4L**
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134S	1	**SMZ-K4L**
2-600	DC-600	5.5/7	7/8	60/50	42/30	37/25	60/45	47/30	36/22	106B	2	**TOP-1LZ**
50-1000	DC-1000	6/7	7.8/9	58/45	45/30	38/25	50/35	40/20	35/18	106B	2	**TOP-2LZ**
20-1500	DC-1000	7.5/8	8.5/9	54/40	42/30	39/25	40/25	32/18	23/8	106B	2	**TOP-5LZ**

NOTES:

* Phase Detection, Polarity Positive
1. 1dB Compression Point = +5 dBm (Typ)
2. IP3 (Input) = +18 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2, 3,6	--
#2	1	4	2	3	3

GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS
DOUBLE-BALANCED

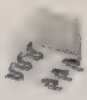
LO = +13 dBm

HIGH DYNAMIC RANGE

SURFACE MOUNT

106B

134


134S

159

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5 - 500	DC - 500	5.5/7	6.0/8.5	55/50	35/25	30/20	55/45	30/25	25/20	159	1	SLD-K1RM*
0.5 - 500	DC - 500	5.5/7	6.0/8.5	55/50	35/25	30/20	55/45	30/25	25/20	134	1	SMD-K1RM*
0.5 - 500	DC - 500	5.5/7	6.0/8.5	55/50	35/25	30/20	55/45	30/25	25/20	134S	1	SMZ-K1RM*
5 - 1000	DC - 1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	159	1	SLD-K2RM*
5 - 1000	DC - 1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	134	1	SMD-K2RM*
5 - 1000	DC - 1000	6.5/8	7/9	60/40	40/20	25/20	55/30	30/20	20/12	134S	1	SMZ-K2RM*
10 - 1000	20 - 500	6.5/8	7.5/9.5	52/40	43/30	33/25	53/30	44/25	39/22	159	1	SLD-K2URM*
10 - 1000	20 - 500	6.5/8	7.5/9.5	52/40	43/30	33/25	53/30	44/25	39/22	134	1	SMD-K2URM*
10 - 1000	20 - 500	6.5/8	7.5/9.5	52/40	43/30	33/25	53/30	44/25	39/22	134S	1	SMZ-K2URM*
5 - 1500	DC - 1000	6.5/8	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	159	1	SLD-K3RM*
5 - 1500	DC - 1000	6.5/8	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	134	1	SMD-K3RM*
5 - 1500	DC - 1000	6.5/8	7.5/9.5	60/40	40/20	30/18	55/30	30/18	15/8	134S	1	SMZ -K3RM*
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	159	1	SLD-K4RM
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134	1	SMD-K4RM
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134S	1	SMZ-K4RM
2-600	DC-600	5.5/7	7/8	60/50	42/30	37/25	60/45	47/30	36/22	106B	2	TOP-1RMZ
50-1000	DC-1000	6/7	7.8/9	58/45	45/30	38/25	50/35	40/20	35/18	106B	2	TOP-2RMZ
20-1500	DC-1000	7.5/8	8.5/9	54/40	42/30	39/25	40/25	28/18	20/8	106B	2	TOP-5RMZ

NOTES:

* Phase Detection, Polarity Positive
1. 1dB Compression Point = +7 dBm (Typ)
2. IP3 (Input) = +20 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2, 3,6	–
#2	1	4	2	3	3

GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS
DOUBLE-BALANCED

LO = +13 dBm

HIGH DYNAMIC RANGE

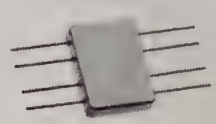
THROUGH HOLE (RELAY)

102

106

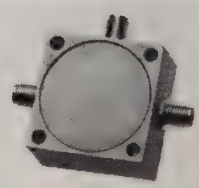
120

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-500	DC-500	5.5/7	6.5/8.5	50/45	45/30	35/25	45/35	40/25	30/20	102	1	**CMP-2D3**
1-500	DC-500	5.5/7.5	6.5/8.5	50/35	45/30	35/25	35/30	40/25	30/20	120	2	**CMP-2C3***
10-2000	DC-600	7/8.5	7.5/9	55/45	45/30	40/30	50/45	35/30	35/25	102	3	**CMP-256**
1-250	DC-200	5/7	6/8.5	50/45	40/30	28/23	45/40	35/25	26/20	106	4	**CMP-3H2**
2-500	DC-500	6/7.5	7/8.5	50/45	40/30	30/20	45/40	35/25	25/20	106	4	**CMP-3H3**



FLAT-PACK

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			OUTLINE DRAWING	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-500	DC-500	6/7	7/9	45/40	45/40	40/30	45/40	40/35	35/25	101	5	**CMF-1A3**



COAXIAL

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5 - 2000	0.2 - 600	5.8/8	7.2/9.5	60/45	35/30	30/25	55/40	30/25	25/20	110	4	**CMK-7A6S**

NOTES:

1. 1dB Compression Point = +7 dBm (Typ)
2. IP3 (Input) = +18 dBm (Typ)

* Non-Hermetic

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	1	8	*3,4	2,5,6,7	2
#2	1	8	*3,4	2,5,6,7	--
#3	1	8	3	2,5,6,7	2,5,6,7
#4	1	4	2	3	3
#5	1	4	5	All Other	All Other
#6	1	3	2	--	--

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

MIXERS

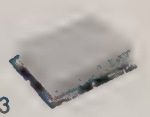
DOUBLE-BALANCED

LO = +17 dBm

VERY HIGH DYNAMIC RANGE

SURFACE MOUNT

106B

133 

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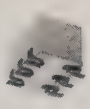
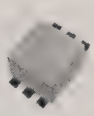
134S 

159 

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-500	DC-500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	159	1	SLD-K1M*
0.5-500	DC-500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	134	1	SMD-K1M*
0.5-500	DC-500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	134S	1	SMZ-K1M*
1-1000	DC-1000	6.5/7.5	7.5/9.5	70/45	45/30	40/25	60/40	35/23	30/15	133	1	SMD-C1M
2-600	DC-600	5.5/7	7/8	60/50	42/30	37/25	60/45	47/30	36/22	106B	2	TOP-1MZ
5-1000	DC-900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/20	39/22	159	1	SLD-K2M*
5-1000	DC-900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/20	39/22	134	1	SMD-K2M*
5-1000	DC-900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/20	39/22	134S	1	SMZ-K2M*
5-1500	DC-900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	159	1	SLD-K3M*
5-1500	DC-900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	134	1	SMD-K3M*
5-1500	DC-900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	134S	1	SMZ-K3M*
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	159	1	SLD-K4M
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134	1	SMD-K4M
5-2500	3-600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134S	1	SMZ-K4M
10-1000	10-750	6.5/8	7/9.5	50/40	38/30	30/23	50/30	40/25	34/22	159	1	SLD-K2UM*
10-1000	10-750	6.5/8	7/9.5	50/40	38/30	30/23	50/30	40/25	34/22	134	1	SMD-K2UM*
10-1000	10-750	6.5/8	7/9.5	50/40	38/30	30/23	50/30	40/25	34/22	134S	1	SMZ-K2UM*
20-1500	DC-1000	7.5/8	8.5/9	54/40	42/30	39/25	40/25	29/18	20/8	106B	2	TOP-5MZ
20-1500	DC-1500	7/8.5	8.5/9	50/35	40/25	20/10	40/25	30/18	15/8	133	1	SMD-C2M
20-2500	20-600	8/9	9/10.5	45/30	30/23	30/15	40/20	25/15	25/12	133	1	SMD-C3M
50-1000	DC-1000	6/7	7.8/9	58/45	45/30	38/25	50/35	4/20	28/18	106B	2	TOP-2MZ

NOTES:

* Phase Detection, Positive Polarity
1. 1dB Compression Point = +10 dBm (Typ)
2. IP3 (Input) = +22 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2, 3,6	--
#2	1	4	2	3	3

GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS
DOUBLE-BALANCED

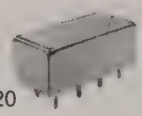
LO = +17 dBm

VERY HIGH DYNAMIC RANGE

THROUGH-HOLE (RELAY)

102

103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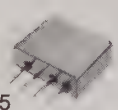
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	102	4	**CMP-202**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	103	4	**CMP-212**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	103	4	**CMP-201**
1-750	DC-750	5.5/7.5	6.5/8.5	50/40	45/25	35/25	45/35	40/30	30/20	102	1	**CMP-2E4**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	103	1	**CMP-203**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	102	1	**CMP-211**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	120	2	**CMP-209**

THROUGH-HOLE (MINI-RELAY)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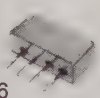
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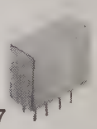
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108

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	105	3	**CMP-302**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	105	3	**CMP-312**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	106	3	**CMP-301**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	106	3	**CMP-303**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	106	3	**CMP-311**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	105	3	**CMP-309**
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	107	4	**CMP-402**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	107	4	**CMP-412**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	108	4	**CMP-401**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	108	1	**CMP-403**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	107	1	**CMP-411**

NOTES:

1. 1dB Compression Point = +10 dBm (Typ)
2. IP3 (Input) = +22 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN
#1	1	8	*3,4	2,5,6,7	2,5,6,7	–
#2	1	8	3	2,5,6,7	2,5,6,7	4
#3	1	4	2	3	3	–
#4	1	8	*3,4	2,5,6,7	2	–

GND = Ground externally
* Pins must be tied together externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

MIXERS
DOUBLE-BALANCED

LO = +17 dBm

VERY HIGH DYNAMIC RANGE

THROUGH-HOLE (RELAY)

102

103

105

106

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05-300	DC-300	5/7	6/8.5	55/45	40/30	30/25	50/40	35/25	25/20	103	1	**CMP-2P2**
1-500	DC-500	5.5/7	6/7	40/30	50/40	40/35	30/23	40/30	35/30	102	2	**CMP-221**
2-500	DC-500	6/7.5	7/8.5	50/40	40/30	30/25	45/35	35/25	25/20	103	1	**CMP-2Q3**
5-750	DC-750	6.2/7.5	7/9	50/40	40/30	30/25	45/35	35/25	30/20	103	3	**CMP-2R4**
0.1-250	DC-250	5/7	6/8.5	50/45	40/30	28/23	45/40	35/25	26/20	106	4	**CMP-3G2**
2-500	DC-500	6/7.5	7/8.5	50/45	40/30	30/20	45/40	35/25	25/20	106	4	**CMP-3G3**
5-1000	DC-1000	6.2/7	7/10	50/45	40/30	30/20	45/40	35/25	20/17	106	4	**CMP-3M4**
5-1200	DC-1200	6.5/8	7/9	50/40	35/25	30/20	50/40	35/20	30/20	105	4	**CMP-3J5**

THROUGH-HOLE (TO CAN)

104

122

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	104	5	**CMP-502**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	104	5	**CMP-512**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	104	5	**CMP-501**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	104	5	**CMP-503**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	122	6	**CMP-612**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	122	6	**CMP-603**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	122	6	**CMP-611**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	122	6	**CMP-609**
800-2500	DC-400	–/–	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	122	6	**CMP-604**

NOTES:

1. 1dB Compression Point = +14 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN
#1	1	8	*3,4	2,5,6,7	2	–
#2	1	8	3	2,5,6,7	2,5,6,7	4
#3	1	8	*3,4	2,5,6,7	2,5,6,7	–
#4	1	4	2	3	3	–
#5	2	5	11	All other	All other	–
#6	1	3	2	4	4	–

* Pins must be tied together
GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS

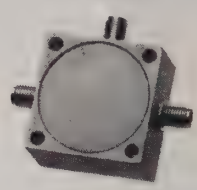
DOUBLE-BALANCED

LO = +17 dBm

VERY HIGH DYNAMIC RANGE

FLAT-PACK

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	101	1	**CMF-102**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	101	1	**CMF-112**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	101	1	**CMF-101**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	101	1	**CMF-103**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	101	1	**CMF-111**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	101	1	**CMF-109**
800-2500	DC-400	--/--	5.5/7	30/20	30/20	30/20	20/10	20/10	20/10	101	1	**CMF-104**



COAXIAL

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	110	2	**CMK-702***
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	110	2	**CMK-712***
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	110	2	**CMK-701***
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	110	2	**CMK-703***
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	110	2	**CMK-711S**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	110	2	**CMK-709S**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	110	2	**CMK-704S**
800-4200	DC-1000	--/--	6/10	25/13	25/13	25/13	20/10	20/10	20/10	110	2	**CMK-215S**
0.05-300	DC-300	5/7	6/8.5	55/45	45/30	30/25	50/40	35/25	25/20	110	2	**CMK-7N2*** ■
5-1000	DC-1000	6.2/7	7/10	50/40	40/30	30/20	45/40	35/25	25/17	110	2	**CMK-7Q4*** ■
5-1200	DC-1200	6.5/8	7/9	50/40	35/25	30/20	50/40	35/20	30/20	110	2	**CMK-7L5S** ■

NOTES:

1) 1dB Compression Point = +10 dBm (Typ)
2) IP3 (Input) = +22 dBm (Typ)

■ 1dB Compression Point = +14dBm (Typ)
■ IP3 (Input) = +26 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

* Connector style: "B" = BNC, "T" = TNC, "N" = Type N, "S" = SMA

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	1	4	5	2,3,6,7,8	2,3,6,7,8
#2	1	3	2	–	–

GND = Ground externally

For pin location and package outline drawings, see back pages.

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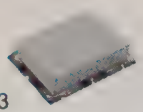
MIXERS

DOUBLE-BALANCED

LO = +23 dBm

Super-High Dynamic Range

SURFACE MOUNT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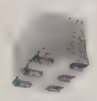
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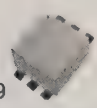
134S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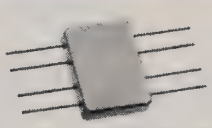
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5 - 500	DC - 500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	159	1	SLD-K1H*
0.5 - 500	DC - 500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	134	1	SMD-K1H*
0.5 - 500	DC - 500	6.2/7	6.4/8.5	55/44	44/25	33/20	50/34	45/25	37/22	134S	1	SMZ-K1H*
1-1000	DC-1000	6.5/7.5	7.5/9.5	70/45	45/30	40/25	60/40	35/23	30/15	133	1	SMD-C1H
5 - 1000	DC - 900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/22	39/22	159	1	SLD-K2H*
5 - 1000	DC - 900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/22	39/22	134	1	SMD-K2H*
5 - 1000	DC - 900	7/8.5	7.8/9.3	55/40	39/22	33/20	52/30	45/22	39/22	134S	1	SMZ-K2H*
5 - 1500	DC - 900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	159	1	SLD-K3H*
5 - 1500	DC - 900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	134	1	SMD-K3H*
5 - 1500	DC - 900	6.3/8	7.5/9.8	65/40	36/20	22/15	50/30	30/18	17/7	134S	1	SMZ -K3H*
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	159	1	SLD-K4H
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134	1	SMD-K4H
5 - 2500	3 - 600	8/9.5	10.5/12	60/35	40/25	35/20	50/35	30/20	25/15	134S	1	SMZ-K4H
20-1500	DC-1500	7.0/8.5	8.5/9.0	50/35	40/25	20/10	40/25	30/18	15/8	133	1	SMD-C2H
20-2500	20-600	8.0/9.0	9.0/10.5	45/30	30/23	30/15	40/20	25/15	25/12	133	1	SMD-C3H

FLAT PACK



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC - 125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	101	2	CHF-102
0.025-200	DC - 200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	101	2	CHF-112
0.1 - 500	DC - 500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	101	2	CHF-101
0.5 - 1000	DC - 1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	101	2	CHF-103
10 - 2000	5 - 600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	101	2	CHF-109
20 - 1500	DC - 1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	101	2	CHF-111
800-2500	DC - 400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	101	2	CHF-104

NOTES:

* Phase Detection, Polarity Positive
1. 1dB Compression Point = +15 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	4	1	5	2, 3,6	–
#2	1	4	5	2,3,6,7,8	2,3,6,7,8

GND = Ground externally
For pin location and package outline drawings, see back pages.

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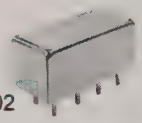
SYNERGY® MICROWAVE CORPORATION

MIXERS
DOUBLE-BALANCED

LO = +23 dBm

Super-High Dynamic Range

THROUGH HOLE (RELAY)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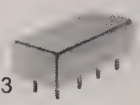
103

120

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	102	1	**CHP-202**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	103	1	**CHP-212**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	103	1	**CHP-201**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	103	2	**CHP-203**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	102	2	**CHP-211**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	120	3	**CHP-209**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	120	3	**CHP-204**

THROUGH HOLE (MINI-RELAY)

105

106

107

108

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	105	4	**CHP-302**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	105	4	**CHP-312**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	106	4	**CHP-301**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	106	4	**CHP-303**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	106	4	**CHP-311**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	105	4	**CHP-309**
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	107	1	**CHP-402**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	107	1	**CHP-412**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	108	1	**CHP-401**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	108	2	**CHP-403**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	107	2	**CHP-411**

NOTES:
1. 1dB Compression Point = +17 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	1	8	*3,4	2,5,6,7	2	--
#2	1	8	*3,4	2,5,6,7	2,5,6,7	--
#3	1	8	3	2,5,6,7	2,5,6,7	4
#4	1	4	2	3	3	--

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

MIXERS
DOUBLE-BALANCED

LO = +23 dBm

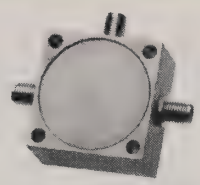
Super-High Dynamic Range

THROUGH HOLE (TO-CAN)

104

122

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	104	1	**CHP-502**
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	104	1	**CHP-512**
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	104	1	**CHP-501**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	104	1	**CHP-503**
5-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	122	2	**CHP-612**
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	122	2	**CHP-603**
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	122	2	**CHP-611**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	122	2	**CHP-609**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	122	2	**CHP-604**



COAXIAL

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.01-125	DC-125	5.5/6	6/6.5	60/50	50/40	40/35	60/45	50/35	40/30	110	3	**CHK-702***
0.025-200	DC-200	5.5/6	6/7	65/55	55/45	45/35	60/50	45/35	35/30	110	3	**CHK-712***
0.1-500	DC-500	6/7	7/8	65/40	60/40	50/30	45/30	50/35	35/20	110	3	**CHK-701***
0.5-1000	DC-1000	5.5/7	7/8.5	70/40	45/35	40/25	60/40	40/30	30/20	110	3	**CHK-703***
20-1500	DC-1000	7.5/8.5	8/9	60/35	40/25	25/20	50/30	40/25	20/12	110	3	**CHK-711S**
10-2000	5-600	7/8.5	7.5/9	60/35	40/25	40/20	50/30	30/20	25/15	110	3	**CHK-709S**
800-2500	DC-400	--/--	6.5/8.5	30/20	30/20	30/20	20/10	20/10	20/10	110	3	**CHK-704S**
800-4200	DC-1000	--/--	6/10	25/13	25/13	25/13	20/10	20/10	20/10	110	3	**CHK-215S**

NOTES:
1. 1dB Compression Point = +17 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

* Connector style: "B" = BNC, "T" = TNC, "N" = Type N, "S" = SMA

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	2	5	11	All Others	All Others
#2	1	3	2	4	4
#3	1	3	2	–	–

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

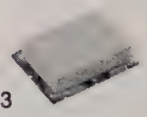
MIXERS

TRIPLE-BALANCED

LO = +10 dBm

IMPROVED DYNAMIC RANGE

SURFACE MOUNT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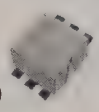
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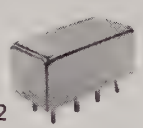
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
5 - 1000	5 - 1000	6.5/8	7.5/9.5	35/20	40/30	30/23	30/20	30/20	25/20	159	1	**SLD-K5**
25 - 1800	25 - 1000	7.5/8.5	8/9	50/30	45/25	35/20	30/15	25/15	23/15	133	2	**SMD-C5**
750 - 2500	50 - 880	7/8.5	8/9.2	44/35	--/--	40/30	38/28	--/--	25/20	133	2	**SMD-C7***
800 - 3550♦	800 - 2500	--/--	10/11.8	--/--	--/--	28/20	--/--	--/--	23/15	133	2	**SMD-C9****

♦ LO Frequency is specified from 600 to 2595 MHz
** UB identifies the full bandwidth specification
*XMB = 750 - 1000 MHz
*LB = 750 - 1200 MHz
*UB = 1200 - 2500 MHz

THROUGH HOLE (RELAY)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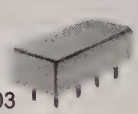
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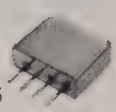
105

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	102	3	**CLP-206**
10 - 1000	5 - 500	6/7.5	7/8	50/40	40/30	30/20	40/25	30/18	25/15	102	4	**CLP-2P4**
0.05 - 1500	0.05 - 500	6/7.5	7/9	25/20	35/25	30/20	25/20	35/25	25/15	102	3	**CLP-2H5**
0.05 - 2000	0.05 - 500	6/8	7/9	25/20	40/30	30/20	25/20	40/30	25/15	102	3	**CLP-2B6**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	35/20	27/20	103	3	**CLP-205**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	103	3	**CLP-210**
10 - 2000	10 - 1000	6/8	6.5/8	32/25	35/25	35/25	33/20	30/20	30/20	105	5	**CLP-3E6**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	105	6	**CLP-305**
10 - 3000	10 - 800	6.3/8	6.5/8.5	35/25	35/25	35/25	30/20	30/20	30/20	105	5	**CLP-3B8**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	105	6	**CLP-310**

NOTES:

1. 1dB Compression Point = +5 dBm (Typ)
2. IP3 (Input) = +18 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

ALL MODELS	MODEL SMD-C7
XMB= 2LF to HF/2 FULL BAND = LF to HF LB= LF to 10LF MB = 10LF to HF/2 UB= HF/2 to HF	XMB = 750 - 1000 MHz LB = 750 - 1200 MHz UB =1200 - 2500 MHz

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	4	1	5	2,3,6	--	--
#2	1	2	3	4,5,6	--	--
#3	1	8	3	2,5,6,7	2,5,6,7	4
#4	8	1	3	2,5,6,7	2,5,6,7	4
#5	4	1	2	3	3	--
#6	1	4	2	3	3	--

GND = Ground externally
For pin location and package outline drawings, see back pages.
*Connect pins together externally.

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SYNERGY® MICROWAVE CORPORATION

MIXERS

TRIPLE-BALANCED

LO = +10 dBm

IMPROVED DYNAMIC RANGE

THROUGH HOLE (TO -CAN)

104

122

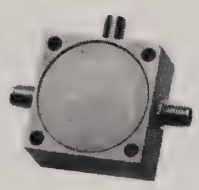
123

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-200	0.5-200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	123	1	**CLP-506**
10-2500	10-1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	104	1	**CLP-505**
10-2500	10-1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	122	2	**CLP-605**
500-3700	500-1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	122	2	**CLP-610**

FLAT PACK

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
10 - 1500	DC - 1500	6/7	6/10	45/40	35/30	25/20	40/35	35/25	20/12	101	3	**CLF-1B5**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	101	3	**CLF-105**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	101	3	**CLF-110**

COAXIAL



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			OUTLINE DRAWING	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	110	4	**CLK-706***
10 - 2000	10 - 1000	6/8	6.5/8.5	32/25	35/25	35/20	33/20	30/20	25/20	110	4	**CLK-7A6S ■**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/20	35/20	30/20	27/20	110	4	**CLK-705S**
10 - 3000	10 - 800	6.3/8	6.5/8.5	35/25	35/25	35/25	30/20	30/20	30/20	110	4	**CLK-7B8S**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	110	4	**CLK-710S**

NOTES:
1. 1dB Compression Point = +5 dBm (Typ)
2. IP3 (Input) = +18 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum

* Connector style: "B" = BNC, "T" = TNC, "N" = Type N, "S" = SMA

■ Double Balanced Model (IP3 & 1dB comp. pt. 3 dB lower than specified.)

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	2	5	11	All Others	All Others	--
#2	1	3	2	4	4	--
#3	1	4	5	All Others	All Others	--
#4	1	3	2	--	--	

GND = Ground externally
For pin location and package outline drawings, see back pages.

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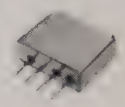
MIXERS
TRIPLE-BALANCED

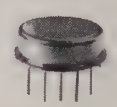
LO = +13 dBm

HIGH DYNAMIC RANGE



THROUGH HOLE (RELAY)

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
		XMB	FULL BAND	LB	MB	UB	LB	MB	UB			
RF/LO	IF	TYP/MAX	TYP/MAX	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN			
0.5 - 2000	0.2 - 600	5.8/8	7.2/9.5	60/45	35/30	30/25	55/40	30/25	25/20	105	1	**CMP-3A6**
10 - 4200	10 - 1000	7.5/8.5	7.5/11	35/25	40/25	35/25	35/20	35/25	27/20	105	2	**CMP-3A8**



THROUGH HOLE (TO-CAN)

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
		XMB	FULL BAND	LB	MB	UB	LB	MB	UB			
RF/LO	IF	TYP/MAX	TYP/MAX	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN	TYP/MIN			
5 - 2500	10 - 1000	6.4/8.5	7/9.5	33/25	35/25	25/20	33/20	30/25	27/20	104	3	**CMP-6A7**

NOTES:
1. 1dB Compression Point = +10 dBm (Typ)
2. IP3 (Input) = +20 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	1	4	2	3	3	–
#2	4	1	2	3	3	–
#3	2	8	11	All Others	–	–

GND = Ground externally
For pin location and package outline drawings, see back pages.

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MIXERS

TRIPLE-BALANCED

LO = +17 dBm

VERY HIGH DYNAMIC RANGE

SURFACE MOUNT

133

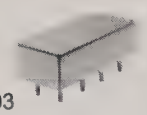
159

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
5 - 1000	5 - 1000	6.5/8	7.5/9.5	35/20	40/30	30/23	30/20	30/20	25/20	159	1	**SLD-K5M**
25 - 1800	25 - 1000	7.5/8.5	8/9	50/30	45/25	35/20	35/15	25/15	23/15	133	2	**SMD-C5M**
750 - 2500	50 - 880	7/8.5	8/9.2	44/35	--/--	40/30	38/28	--/--	25/20	133	2	**SMD-C7M***

*XMB = 750 - 1000 MHz
*LB = 750 - 1200 MHz
*UB = 1200 - 2500 MHz

THROUGH HOLE (RELAY)

102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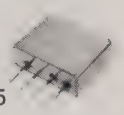
105

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.5-200	0.5-200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/20	102	3	**CMP-206**
5-1200	1-200	6/7	7/8.5	50/35	45/30	40/25	40/30	35/25	35/20	102	4	**CMP-231**
10-2500	10-1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	103	3	**CMP-205**
10-2500	10-1000	7.0/8.0	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	105	5	**CMP-305**
10-3000	10-1000	8/11	10/12	29/20	25/18	23/14	27/20	25/12	23/16	102	3	**CMP-2A8**
500-3700	500-1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	103	3	**CMP-210**
500-3700	500-1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	105	5	**CMP-310**

NOTES:
1. 1dB Compression Point = +14 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	4	1	5	2,3,6	--	--
#2	1	2	3	4,5,6	--	--
#3	1	8	3	2,5,6,7	2,5,6,7	4
#4	1	*2,6	8	3,4,5,7	3,4,5,7	--
#5	1	4	2	3	3	--

* Pins must be grounded together
GND = Ground externally
For pin location and package outline drawings, see back pages.

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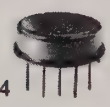
MIXERS

TRIPLE-BALANCED

LO = +17 dBm

VERY HIGH DYNAMIC RANGE

THROUGH HOLE (TO-CAN)

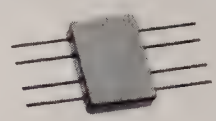

104

122

123

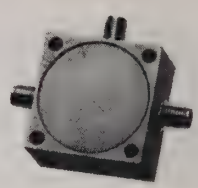
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	123	1	**CMP-506**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	104	1	**CMP-505**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	122	2	**CMP-605**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	122	2	**CMP-610**

FLAT-PACK



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	101	3	**CMF-105**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	101	3	**CMF-110**

COAXIAL



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	110	4	**CMK-706***
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	110	4	**CMK-705S**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	110	4	**CMK-710S**

NOTES:

1. 1dB Compression Point = +14 dBm (Typ)
2. IP3 (Input) = +26 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

* Connector style: "B" = BNC, "T" = TNC, N" = Type N, "S" = SMA

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	2	5	11	All Others	All Others
#2	1	3	2	4	4
#3	1	4	5	2,3,6,7,8	2,3,6,7,8
#4	1	3	2	–	–

GND = Ground externally

For pin location and package outline drawings, see back pages.

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MIXERS

TRIPLE-BALANCED

LO = +23 dBm

SUPER HIGH DYNAMIC RANGE

SURFACE MOUNT

133

159

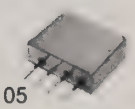
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
5 - 1000	5 - 1000	6.5/8	7.5/9.5	35/20	40/30	30/23	30/20	30/20	25/20	159	1	SLD-K5H
25 - 1800	25 - 1000	7.5/8.5	8/9	50/30	45/25	35/20	35/15	25/15	23/15	133	2	SMD-C5H
750 - 2500	50 - 880	7/8.5	8/9.2	44/35	--/--	40/30	38/28	--/--	25/20	133	2	SMD-C7H*

*XMB = 750 - 1000 MHz
*LB = 750 - 1200 MHz
*UB = 1200 - 2500 MHz

THROUGH HOLE (RELAY)

102

103


105

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	102	3	CHP-206
0.1 - 500	0.5 - 500	5.3/6	5.3/7.5	40/20	46/35	40/30	37/23	46/35	40/30	102	3	CHP-2B3
0.1 - 1000	0.01 - 500	5.3/7.5	7.5/9.5	40/20	40/30	30/25	37/23	40/25	25/20	102	3	CHP-2A4
10 - 2400	5 - 1000	7/8.5	8/10	28/20	26/20	25/20	28/20	26/20	25/20	102	3	CHP-2B7
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	103	3	CHP-205
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	105	4	CHP-305
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	103	3	CHP-210
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	105	4	CHP-310

NOTES:
1. 1dB Compression Point = +20 dBm (Typ)
2. IP3 (Input) = +30 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	4	1	5	2,3,6	--	--
#2	1	2	3	4,5,6	--	--
#3	1	8	3	2,5,6,7	2,5,6,7	4
#4	1	4	2	3	3	--

GND = Ground externally
For pin location and package outline drawings, see back pages.

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TRIPLE-BALANCED

LO = +23 dBm

SUPER HIGH DYNAMIC RANGE

THROUGH HOLE (TO-CAN)

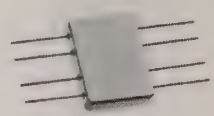
104

122

123

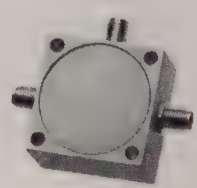
FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	123	1	**CHP-506**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	104	1	**CHP-505**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	122	2	**CHP-605**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	122	2	**CHP-610**

FLAT-PACK



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	101	3	**CHF-105**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	101	3	**CHF-110**

COAXIAL



FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	110	4	**CHK-706***
0.1 - 500	0.01 - 500	5.3/6	5.3/7.5	47/20	46/35	40/30	47/40	46/35	40/30	110	4	**CHK-7M3***
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	110	4	**CHK-705S**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	110	4	**CHK-710S**

NOTES:

1. 1dB Compression Point = +20 dBm (Typ)
2. IP3 (Input) = +30 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

*Connector style: "B" = BNC, "T" = TNC, "N" = Type N, "S" = SMA

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	2	5	11	All Others	All Others	--
#2	1	3	2	4	4	--
#3	1	4	5	2,3,6,7,8	2,3,6,7,8	--
#4	1	3	2	--	--	

GND = Ground externally

For pin location and package outline drawings, see back pages.

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LO = +27 dBm

ULTRA HIGH DYNAMIC RANGE

THROUGH HOLE (RELAY)

102

103

105

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	102	1	**CVP-206**
0.5 - 500	0.2 - 500	6/7.5	7.5/8.5	47/40	46/35	35/25	47/40	46/35	35/25	102	1	**CVP-2K3**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	103	1	**CVP-205**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	103	1	**CVP-210**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	105	2	**CVP-305**
500 - 3700	500 - 1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	105	2	**CVP-310**

THROUGH HOLE (TO-CAN)

104

122

123

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	123	3	**CVP-506**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	104	3	**CVP-505**
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	122	4	**CVP-605**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	122	4	**CVP-610**

NOTES:

1. 1dB Compression Point = +24 dBm (Typ)
2. IP3 (Input) = +34 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND	NO CONN.
#1	1	8	3	2,5,6,7	2,5,6,7	4
#2	1	4	2	3	3	--
#3	2	5	11	all others	all others	--
#4	1	3	2	4	4	--

GND = Ground externally

For pin location and package outline drawings, see back pages.

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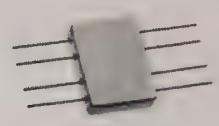
MIXERS
TRIPLE-BALANCED

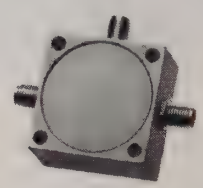
LO = +27 dBm

ULTRA HIGH DYNAMIC RANGE



FLAT PACK

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	101	1	**CVF-105**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	101	1	**CVF-110**



COAXIAL

FREQUENCY RANGE (MHz)		CONVERSION LOSS (dB)		LO-RF ISOLATION (dB)			LO-IF ISOLATION (dB)			PACKAGE	PIN OUT	MODEL
RF/LO	IF	XMB TYP/MAX	FULL BAND TYP/MAX	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN			
0.05 - 200	0.05 - 200	5.5/6.5	6.5/7	45/30	50/45	45/40	35/25	40/35	35/30	110	2	**CVK-706***
10 - 2500	10 - 1000	7/8	7.5/8.5	55/35	45/30	35/25	35/20	30/20	27/20	110	2	**CVK-705S**
500 - 3700	500 -1000	--/--	9.5/11.5	45/25	45/25	45/25	40/20	40/20	40/20	110	2	**CVF-710S**

NOTES:
1. 1dB Compression Point = +24 dBm (Typ)
2. IP3 (Input) = +34 dBm (Typ)
3. As IF frequency decrease below LF towards DC, conversion loss increases up to 8 dB higher than maximum.

XMB= 2LF to HF/2
FULL BAND = LF to HF
LB= LF to 10LF
MB = 10LF to HF/2
UB= HF/2 to HF

* Connector style: "B" = BNC, "T" = TNC, "N" = Type N, "S" = SMA

PIN-OUT TABLE

	RF	LO	IF	GND	CASE GND
#1	1	4	5	2,3,6,7,8	2,3,6,7,8
#2	1	3	2	–	–

GND = Ground externally
For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

HIGH-IP3
TRIPLE-BALANCED MIXERS

LO = +17 dBm

SURFACE MOUNT

133M

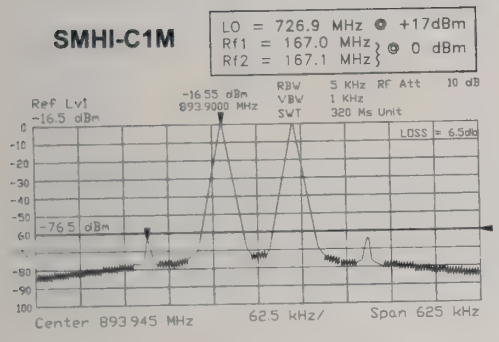
FREQUENCY RANGE (MHz)			CONVERSION LOSS (dB)	ISOLATION (dB)			1dB Comp. Pt. (dBm)	Input IP_3 (dBm)	Package	PIN OUT	MODEL
RF	LO	IF	Max.	LO/RF	LO/IF	IF/RF	Min.	Min.			
820-850	750-780	60-75	9.0	30	30	20	+12	+30	133M	1	**SMHI-C2M**
865-898	700-730	165-168	9.0	30	30	20	+12	+30	133M	1	**SMHI-C1M**
1845-1920	1705-1780	135-145	9.0	30	30	20	+12	+30	133M	1	**SMHI-C3M**

PIN-OUT TABLE

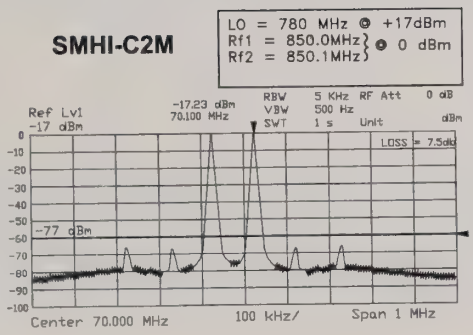
	RF	LO	IF	GND
#1	1	2	3	4,5,6

GND = Ground externally
For pin location and package outline drawings, see back pages.

SMHI-C1M



SMHI-C2M



SMHI-C3M

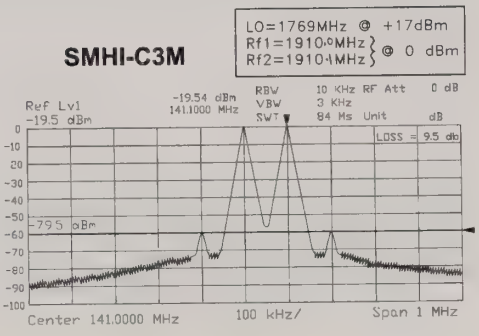


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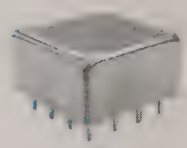
IMAGE REJECT MIXERS



THROUGH HOLE MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS (dB)		IMAGE REJECTION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	ISOLATION (dB)		PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	TYP	MAX	TYP	MIN	MAX	MIN	MIN	LO/RF TYP/MIN	LO/IF TYP/MIN			
40 - 80	20 - 100	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	124	1	**IMP-921**
40 - 80	10 - 110	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	124	1	**IMP-931**
80 - 160	60 - 180	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124	1	**IMP-922**
80 - 160	50 - 190	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124	1	**IMP-932**
80 - 160	40 - 200	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124	1	**IMP-942**
80 - 160	20 - 220	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124	1	**IMP-962**
80 - 160	10 - 230	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124	1	**IMP-972**
100 - 200	80 - 220	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124	1	**IMP-923**
100 - 200	70 - 230	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124	1	**IMP-933**
100 - 200	60 - 240	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124	1	**IMP-943**
100 - 200	40 - 260	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124	1	**IMP-963**
100 - 200	30 - 270	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124	1	**IMP-973**
150 - 300	130 - 320	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124	1	**IMP-924**
150 - 300	120 - 330	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124	1	**IMP-934**
150 - 300	110 - 340	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124	1	**IMP-944**
150 - 300	90 - 360	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124	1	**IMP-964**
150 - 300	80 - 370	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124	1	**IMP-974**
200 - 400	180 - 420	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124	1	**IMP-925**
200 - 400	170 - 430	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124	1	**IMP-935**
200 - 400	160 - 440	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124	1	**IMP-945**
200 - 400	140 - 460	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124	1	**IMP-965**
200 - 400	130 - 470	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124	1	**IMP-975**
400 - 550	400 - 550	50 - 90	+ 13	7	9	25	17	1.5:1	+ 6	+ 18	43/35	35/25	124	2	**IMP-916**
550 - 750	550 - 750	50 - 90	+ 13	7	9	25	17	1.5:1	+ 6	+ 18	42/35	35/25	124	2	**IMP-926**
750 - 1000	750 - 1000	50 - 90	+ 13	7.5	9	25	17	1.5:1	+ 6	+ 18	40/35	35/25	124	2	**IMP-936**
1358 - 1453	1428 - 1523	70	+ 10	7	9	20	15	2:1	- 4	+ 10	30/25	20/15	124	1	**IMP-917**
2238 - 2410	2308 - 2480	70	+ 10	7	9	20	15	2:1	- 4	+ 10	25/20	20/15	124	1	**IMP-928**

Notes:
IF_1 is rejected when the RF frequency is lower than the LO frequency.
IF_2 is rejected when the RF frequency is higher than the LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	1	16	4	13	All Other
#2	3	16	1	5	All Other

For pin location and package outline drawings, see back pages.

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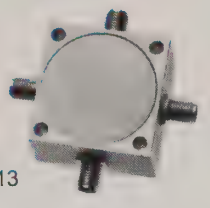
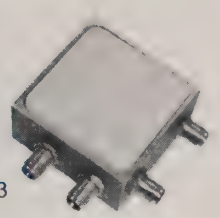
IMAGE REJECT MIXERS


113


153

COAXIAL CONNECTOR MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS (dB)		IMAGE REJECTION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	ISOLATION (dB)		PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	TYP	MAX	TYP	MIN	MAX	MIN	MIN	LO/RF TYP/MIN	LO/IF TYP/MIN			
3 - 30	3 - 30	10.7	+ 13	7	9	20	17	2:1	+ 6	+ 18	60/35	55/35	153	2	**IRK3A-10**
20 - 500	20 - 500	10 - 11	+ 10	7	9.5	20	15	2:1	+ 3	+ 15	38/35	30/25	153	2	**IRK20A-25**
30 - 450	30 - 450	21.4	+ 13	7	10	20	15	2:1	+ 6	+ 18	38/35	30/25	153	2	**IRK30A-15**
40 - 80	20 - 100	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	113	1	**IMK-721***
40 - 80	10 - 110	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	113	1	**IMK-731***
80 - 160	60 - 180	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	113	1	**IMK-722***
80 - 160	50 - 190	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	113	1	**IMK-732***
80 - 160	40 - 200	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	113	1	**IMK-742***
80 - 160	20 - 220	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	113	1	**IMK-762***
80 - 160	10 - 230	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	113	1	**IMK-772***
100 - 200	80 - 220	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	113	1	**IMK-723***
100 - 200	70 - 230	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	113	1	**IMK-733***
100 - 200	60 - 240	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	113	1	**IMK-743***
100 - 200	40 - 260	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	113	1	**IMK-763***
100 - 200	30 - 270	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	113	1	**IMK-773***
150 - 300	130 - 320	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	113	1	**IMK-724***
150 - 300	120 - 330	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	113	1	**IMK-734***
150 - 300	110 - 340	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	113	1	**IMK-744***
150 - 300	90 - 360	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	113	1	**IMK-764***
150 - 300	80 - 370	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	113	1	**IMK-774***
200 - 400	180 - 420	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	113	1	**IMK-725***
200 - 400	170 - 430	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	113	1	**IMK-735***
200 - 400	160 - 440	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	113	1	**IMK-745***
200 - 400	140 - 460	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	113	1	**IMK-765***
200 - 400	130 - 470	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	113	1	**IMK-775***
500 - 1110	500 - 1110	10 -11	+ 10	7	10	20	15	2:1	+ 2	+ 12	38/25	32/20	153	2	**IRK500A-2**
600 - 900	890 - 910	10 - 300	+ 23	7	10	23	20	1.8:1	+ 16	+ 25	30/20	25/20	153	2	**IRK600A-1**
658	660 - 680	2 - 22	+ 10	7	9	23	17	1.8:1	+ 2	+ 13	40/35	35/27	153	2	**IRK658A-1**
800 - 2000	800 - 2000	21.4	+ 13	7	10	20	15	2:1	+ 5	+ 16	35/30	30/20	153	2	**IRK800A-2**
2200 - 2414	2483 - 2500	225	+ 10	7	10	23	18	2:1	+ 2	+ 12	35/30	28/20	113	1	**IMK-718S**
2500 - 2750	2435 - 2685	65 - 75	+ 10	7	9	20	15	2.2:1	+ 2	+ 12	30/25	25/20	113	1	**IMK-738S**

Notes:
IF_1 is rejected when the RF frequency is lower than the LO frequency.
IF_2 is rejected when the RF frequency is higher than the LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC.
All other models numbers are available with SMA connectors only.

PORT CONFIGURATION TABLE

	RF	LO	IF_1	IF_2
#1	1	3	2	4
#2	3	1	2	4

For pin location and package outline drawings, see back pages.

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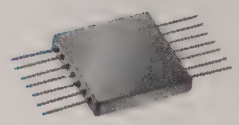
IMAGE REJECT MIXERS



FLAT PACK MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS (dB)		IMAGE REJECTION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	ISOLATION (dB)		PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	TYP	MAX	TYP	MIN	MAX	MIN	MIN	LO/RF TYP/MIN	LO/IF TYP/MIN			
40 - 80	20 - 100	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	115	1	**IMF-221**
40 - 80	10 - 110	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	115	1	**IMF-231**
80 - 160	60 - 180	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	115	1	**IMF-222**
80 - 160	50 - 190	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	115	1	**IMF-232**
80 - 160	40 - 200	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	115	1	**IMF-242**
80 - 160	20 - 220	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	115	1	**IMF-262**
80 - 160	10 - 230	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	115	1	**IMF-272**
100 - 200	80 - 220	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	115	1	**IMF-223**
100 - 200	70 - 230	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	115	1	**IMF-233**
100 - 200	60 - 240	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	115	1	**IMF-243**
100 - 200	40 - 260	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	115	1	**IMF-263**
100 - 200	30 - 270	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	115	1	**IMF-273**
150 - 300	130 - 320	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	115	1	**IMF-224**
150 - 300	120 - 330	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	115	1	**IMF-234**
150 - 300	110 - 340	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	115	1	**IMF-244**
150 - 300	90 - 360	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	115	1	**IMF-264**
150 - 300	80 - 370	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	115	1	**IMF-274**
200 - 400	180 - 420	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	115	1	**IMF-225**
200 - 400	170 - 430	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	115	1	**IMF-235**
200 - 400	160 - 440	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	115	1	**IMF-245**
200 - 400	140 - 460	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	115	1	**IMF-265**
200 - 400	130 - 470	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	115	1	**IMF-275**

Notes:
IF_1 is rejected when the RF frequency is lower than the LO frequency.
IF_2 is rejected when the RF frequency is higher than the LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	1	14	3	10	All Other

For pin location and package outline drawings, see back pages.

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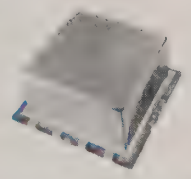
IMAGE REJECT MIXERS



SURFACE-MOUNT MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS (dB)		IMAGE REJECTION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	ISOLATION (dB)		PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	TYP	MAX	TYP	MIN	MAX	MIN	MIN	LO/RF TYP/MIN	LO/IF TYP/MIN			
40 - 80	20 - 100	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	124S	1	IMS-921
40 - 80	10 - 110	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	60/35	55/30	124S	1	IMS-931
80 - 160	60 - 180	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124S	1	IMS-922
80 - 160	50 - 190	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124S	1	IMS-932
80 - 160	40 - 200	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124S	1	IMS-942
80 - 160	20 - 220	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124S	1	IMS-962
80 - 160	10 - 230	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	55/35	50/30	124S	1	IMS-972
100 - 200	80 - 220	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124S	1	IMS-923
100 - 200	70 - 230	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124S	1	IMS-933
100 - 200	60 - 240	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124S	1	IMS-943
100 - 200	40 - 260	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124S	1	IMS-963
100 - 200	30 - 270	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	50/35	45/30	124S	1	IMS-973
150 - 300	130 - 320	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124S	1	IMS-924
150 - 300	120 - 330	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124S	1	IMS-934
150 - 300	110 - 340	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124S	1	IMS-944
150 - 300	90 - 360	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124S	1	IMS-964
150 - 300	80 - 370	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	45/35	40/30	124S	1	IMS-974
200 - 400	180 - 420	20	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124S	1	IMS-925
200 - 400	170 - 430	30	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124S	1	IMS-935
200 - 400	160 - 440	40	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124S	1	IMS-945
200 - 400	140 - 460	60	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124S	1	IMS-965
200 - 400	130 - 470	70	+ 10	7.5	9	30	20	1.5:1	+ 3	+ 15	40/35	35/30	124S	1	IMS-975
400 - 550	400 - 550	50-90	+ 13	7	9	25	17	1.5:1	+ 6	+ 18	43/35	35/28	124S	2	IMS-916
550 - 750	550 - 750	50-90	+ 13	7	9	25	17	1.5:1	+ 6	+ 18	42/35	35/28	124S	2	IMS-926
750 - 1000	750 - 1000	50-90	+ 13	7.5	9	25	17	1.5:1	+ 6	+ 18	40/35	35/23	124S	2	IMS-936
1358 - 1453	1428 - 1523	70	+ 10	7	9	20	15	2:1	- 4	+ 10	30/25	20/15	124S	1	IMS-917
2238 - 2410	2308 - 2480	70	+ 10	7	9	20	15	2:1	- 4	+ 10	25/20	20/15	124S	1	IMS-928

Notes:
IF_1 is rejected when the RF frequency is lower than the LO frequency.
IF_2 is rejected when the RF frequency is higher than the LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	1	16	4	13	All Other
#2	3	16	1	5	All Other

For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

NOVEL I/Q MODULATORS MIX CELLULAR SIGNALS

Shankar R. Joshi, Chief Engineer, Synergy Microwave Corp.

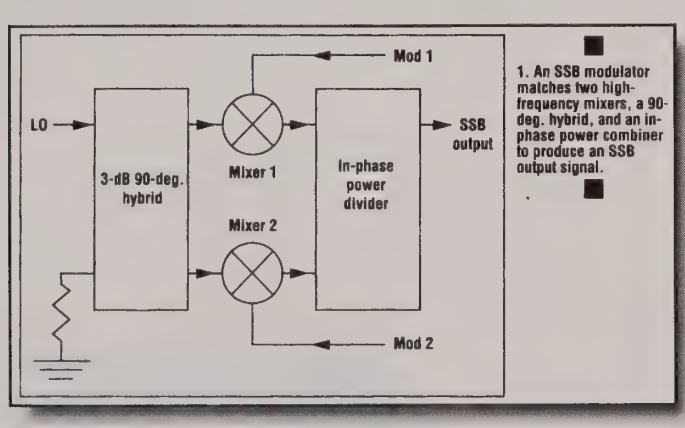
Single Sideband (SSB) or in-phase (I)/quadrature (Q) modulators are used extensively in communications systems, including cellular and personal-communications-systems (PCS) networks. Although the basic design is fairly mature, it has been completely revamped thanks to an innovative technique developed by Synergy Microwave Corp. The novel approach is based on subharmonic mixing techniques and is applicable from about 140 to 3000 MHz.

In a communications receiver, SSB or I/Q modulators are useful in discriminating and removing the lower sideband (LSB) or upper sideband (USB) generated during frequency conversion, especially when the sidebands are very close in frequency and attenuation of one of the sidebands cannot be achieved with filtering. This is the case with audio and video modulation, where signals from DC to 10 MHz must be converted to a higher frequency that is appropriate for transmission. In such cases, both sidebands will be very close in frequency to the carrier frequency. With an I/Q modulator, one of the sidebands is easily canceled or attenuated along with its carrier.

Attenuation of the carrier has been the most troublesome aspect in the design of passive I/Q modulators. Isolation between the local-oscillator (LO) port and the RF port of the mixers, which is the main parameter in determining carrier rejection, is usually insufficient at frequencies above 200 MHz.

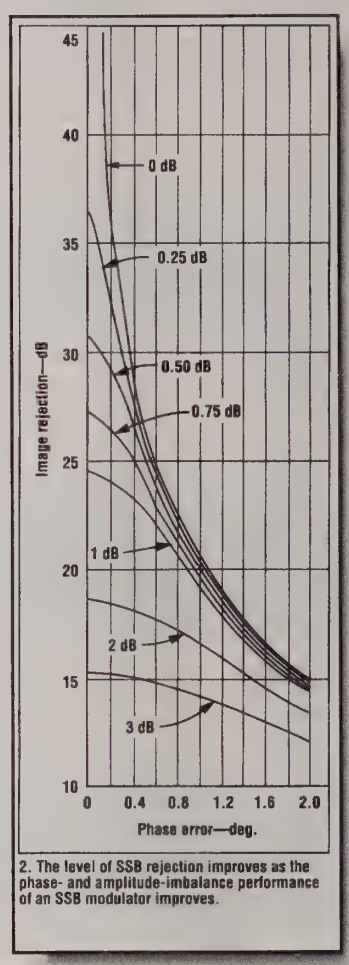
I/Q modulator designs were basically comprised of two double-balanced mixers (Fig. 1). The mixers are fed at the LO ports by a carrier phase-shifted through a 90 deg. hybrid. Thus, the carrier signal's relative phase is 0 deg. to one mixer and 90 deg. to the other mixer. Modulation signals are fed externally in phase quadrature to the two mixers' IF ports. The mixers' modulated output signals are combined through a two-way, in-phase power divider/combiner.

The circuit forms a phase-cancellation network to one of the sidebands and a phase-addition network to the other sideband. The carrier is somewhat attenuated and is directly dependent on the inherent LO-to-RF isolation of the mixers and the modulating signal level. In a standard line of I/Q modulators from Synergy, USB suppression results when the first modulation port (MOD 1) is fed with a signal that is 90 deg. in advance of the signal feeding the second modulation port (MOD 2). Opposite phasing can be arranged by changing the internal phase polarity of the mixers or by interchanging the 90-deg. hybrid output ports to the LO ports of the mixers.



1. An SSB modulator matches two high-frequency mixers, a 90-deg. hybrid, and an in-phase power combiner to produce an SSB output signal.

The phase and amplitude imbalances between the various components used in the manufacturing of the I/Q modulators must be tightly maintained for optimum SSB rejection. Matching of the two mixers for conversion loss and insertion phase is extremely critical, since differences in these parameters will add to amplitude- and phase-imbalance errors. The 90-deg. hybrid in the LO port must be in nearly perfect phase quadrature.



2. The level of SSB rejection improves as the phase- and amplitude-imbalance performance of an SSB modulator improves.

Phase- and amplitude-imbalance errors adversely affect sideband suppression (Fig. 2). In most cases, a typical passive I/Q modulator operates with a carrier input level of +10dBm, which is required to drive the diodes in the mixers to operate in the linear range. The dynamic range of these mixers can be significantly improved by using diodes with a higher barrier height. The LO signal in this case must be increased in order to drive these diodes into conduction in their linear range.

Carrier rejection is also a problem when designing an SSB modulator, since only a few decibels of suppression can be achieved in standard high-frequency models. In the past, the major contributor to carrier suppression was the inherent LO-to-RF isolation through the mixers. Unfortunately, this isolation is usually poor at cellular frequencies (800 to 1000 MHz), where at least 25-dB carrier rejection is necessary. In some cases, designers feed a small amount of DC into the IF ports to control the carrier rejection, which complicates the driver circuitry and calls for temperature compensation when operating at different temperatures.

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As an example, an SSB modulator is assumed to operate with +10-dBm LO drive with each modulating signal at -10 dBm and in phase quadrature to each other when applied to the modulating ports (MOD 1 and MOD 2). The result will be a modulated signal at -16 dBm, assuming 6-dB conversion loss. For 20-dB carrier rejection with respect to the desired modulated signal, the carrier must be at -36 dBm, which translates to LO-to-RF isolation of 46 dB.

By employing a the sub-harmonic approach, the engineers at Synergy have extended the performance of SSB modulators beyond the limits of conventional designs. The approach is based on the use of subharmonic mixers in place of fundamental-frequency mixers. Subharmonic mixers use anti-parallel diode pairs in their construction. [1-3] Matched anti-parallel diode pairs used in single-ended or single-balanced mixer configurations cancel even-order intermodulation products (such as 2LO x 2RF, 3LO x 3RF, etc.) at all ports.

Single-ended mixers lack the port-to-port isolation needed for SSB modulator applications. Odd-order products of the RF and LO frequencies (even LO x odd RF) and (odd LO x even RF) appear on all ports, requiring extensive filtering for satisfactory performance. For a single-balanced mixer, even harmonics of the LO combining with odd harmonics of the RF appear at the IF port, whereas odd harmonics of the LO combining with even harmonics of the RF appear at the RF and IF ports. This assumes that a balanced transformer is placed at the LO port, which is a logical choice due to the fact that the highest level signal appears at the LO port. Since the desired odd-order IF products appear at both the RF and IF ports, a need arises for a diplexing network to isolate the RF and IF signals.

The subharmonic modulator design provides a unique way to isolate the RF and IF signals. A single-balanced harmonic mixer offers good LO-to-RF and LO-to-IF isolation but poor RF-to-IF isolation. Fortunately, harmonically-related signals are spaced well apart in the frequency spectrum, simplifying filtering of harmonically-related signals.

Harmonic mixing also works well with low LO power levels, with somewhat lower 1-dB compression on the RF port than with fundamental-frequency mixing. The ability to operate with LO frequencies that are a fraction of the carrier frequency (1/2, 1/4, 1/6, etc.) significantly reduces the cost of an LO source, especially at higher frequencies. Also, using lower-frequency LO sources helps avoid the signal-leakage problems inherent with higher-frequency LO sources. Minimizing signal leakage, especially at higher frequencies, becomes expensive and bulky. Subharmonic mixing offers several advantages:

(1) The technique offers the ability to operate at LO frequencies that are 1/2, 1/4, or 1/6 of the carrier frequency. For example, for an IF of 100 MHz at an RF of 2 GHz, the LO can be (2000-100)/2 = 950 or 1050 MHz.
(2) The LO's even harmonics are strongly attenuated.
(3) The filtering requirements for fundamental frequency and odd harmonic signals of the LO are not critical.
(4) The cost of generating the LO is reduced due to the fact that the LO frequency need only be a fraction of the carrier frequency.

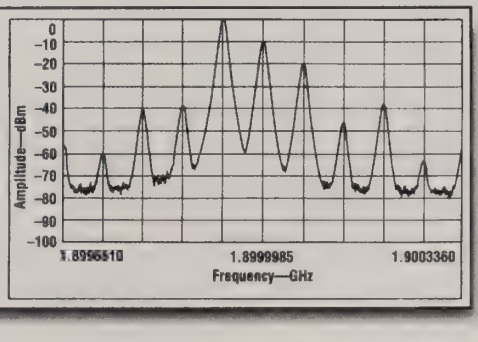
The novel design approach has opened the way for a new line of products specifically designed for applications in the cellular bands. Models for cellular frequency coverage extend from 810 to 2500 MHz with applications in a wide range of systems, including the Advanced Mobile Phone Service (AMPS), the Digital European Cordless Telephone (DECT) system, the European Global System for Mobile Communications (GSM), the Nordic Mobile Telephone (NMT) system, the North American Digital Cellular (IS-54 and IS-95 standards) system, the Japanese Personal Handy Phone (PHP), and the Total Access Communications System (TACS). As an example of the performance improvements possible with the subharmonic mixers, units were evaluated at both cellular (935 to 960-MHz) and PCN/PCS (1.8-to-1.9GHz) bands. For a conventional SSB modulator at 1.9 GHz fed with +10dBm modulation signals, carrier rejection is barely 10 dB (Fig. 3).

Sideband rejection can be improved by tuning, but the carrier rejection is controlled by the LO-to-RF isolation of the double-balanced mixers. Conventional double-balanced mixers with high isolation at cellular and PCN bands are very expensive and large when special techniques are used to improve LO to-RF isolation. In contrast, the subharmonic nature of the new approach allows the use of lower-frequency, less-expensive components in the modulators' construction.

The subharmonic modulators offer an improvement of more than 15 dB in carrier suppression compared to the conventional approach.

The measured VSWR (return loss) at the LO and RF ports is better than 1.50:1 (Figs. 4 and 5). Measurements made on

3.This plot of carrier and sideband rejection was measured for a conventional SSB modulator operating at 1.9 GHz.



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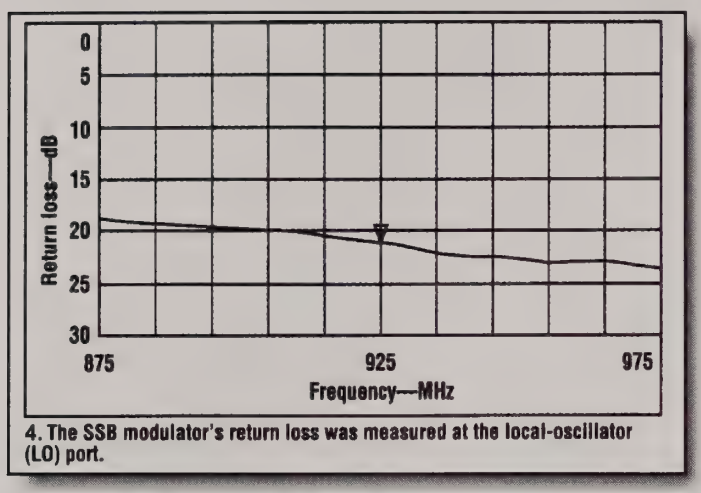
a cellular-band SSB modulator reveal carrier rejection on the order of 40 dB. Typical insertion loss is 7 dB while sideband rejection is 30 dB (Fig. 6).

By the virtue of harmonic mixing, even-order mixing products are attenuated by about 30 dB with respect to the desired modulated output signal. The fundamental-frequency feed through into the output port is approximately 5 dB lower than the desired modulated signal, whereas the fourth harmonic mixing with the modulating signal is approximately 10 dB lower. Typical loss for fourth-harmonic mixing is 17 to 19 dB while maintaining 30 dB of carrier rejection.



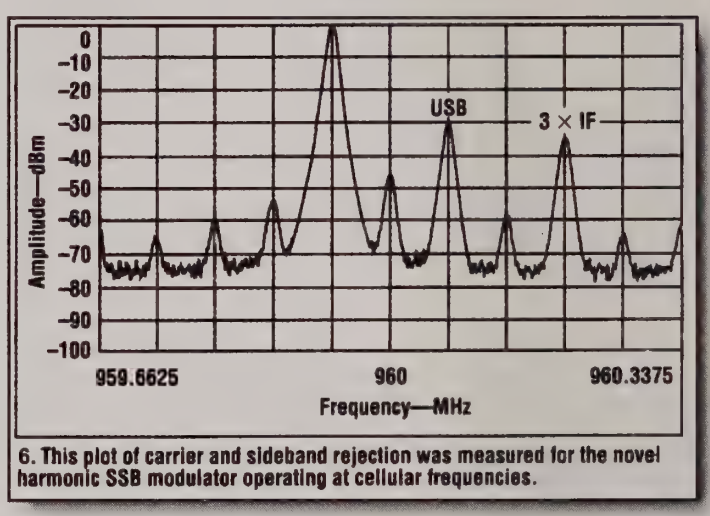
4. The SSB modulator's return loss was measured at the local-oscillator (LO) port.

Since harmonically-related products are well-spaced in frequency, filtering undesired signals is relatively inexpensive using standard octaveband bandpass filters. Low-cost commercial bandpass filters typically offer better than 40-to-50-dB attenuation of unwanted harmonic signals. Constant-impedance bandpass filters offering good impedance match at desired stopbands can also be used in cases where harmonically related products require impedance termination within a system.

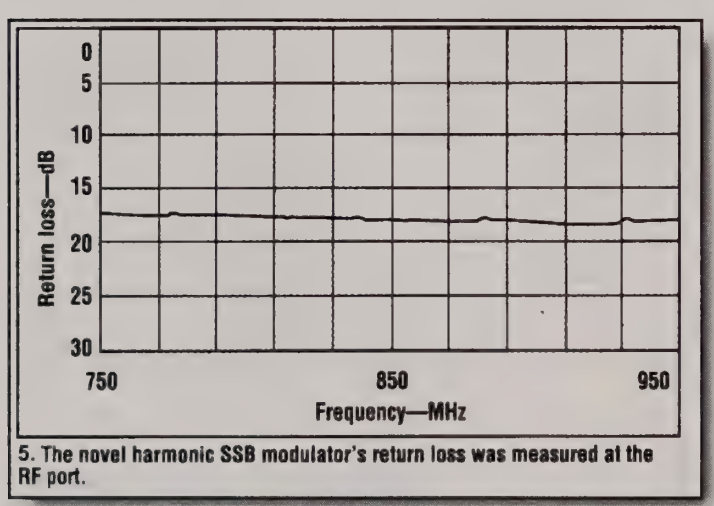
The subharmonic modulator design is easily retrofitted to custom frequencies. Conversion of an SSB modulator with output frequency corresponding to twice the LO frequency to one with output corresponding to four times the LO frequency requires only one component change, in the form of a signal-combining network at the modulator's output. Although the conversion loss of the fourth-harmonic LO component mixing with the modulating signal is in the vicinity of 18 dB, the cost of generating the LO is drastically reduced with the subharmonic modulator. In spite of higher signal loss, the carrier rejection is still at least 30 dB at the fourth harmonic, and harmonically related products can be eliminated with an inexpensive filter.

References:

1. Joseph T. Lee, "*Balanced Subharmonic Mixers*" *Microwave Journal*, August 1983.
2. Don Neuf, "*Fundamental versus Harmonic Mixing*" *Microwave Journal*, 1984.
3. Bert Henderson, "*Full-Range Orthogonal Circuit Mixers Reach 2 to 26 GHz*", *Microwave Systems News*, January, 1982.



6. This plot of carrier and sideband rejection was measured for the novel harmonic SSB modulator operating at cellular frequencies.



5. The novel harmonic SSB modulator's return loss was measured at the RF port.

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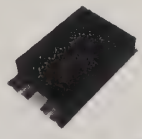
I&Q SUB-HARMONIC MODULATORS

8 PIN - RELAY HEADER

RF OUTPUT FREQUENCY (MHz)	CARRIER FREQUENCY (MHz)	NOMINAL CARRIER POWER (dBm)	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	CARRIER REJECTION (dB) MIN	HARMONIC REJECTION (dB) MIN	PACKAGE	PIN-OUT (See Below)	MODEL
810 - 830	405 - 415	+10	11.0	30	30	33	102	1	**HSMR-810**
825 - 875	412 - 438	+10	11.0	30	30	33	102	1	**HSMR-825**
869 - 894	434 - 447	+10	11.0	30	30	33	102	1	**HSMR-869**
935 - 970	467 - 485	+10	11.0	30	30	33	102	1	**HSMR-935**
1000 - 1070	500 - 535	+10	11.0	30	30	33	102	1	**HSMR-1000**
1200 - 1280	600 - 640	+10	11.0	30	30	33	102	1	**HSMR-1200**
1400 - 1500	700 - 750	+10	11.0	30	30	33	102	1	**HSMR-1400**
1500 - 1650	750 - 825	+10	11.0	30	30	33	102	1	**HSMR-1500**
1800 - 1900	900 - 950	+10	12.0	25	25	30	102	1	**HSMR-1800**
1805 - 1880	902 - 940	+10	12.0	25	25	30	102	1	**HSMR-1805**
1920 - 2000	960 - 1000	+10	12.0	25	25	30	102	1	**HSMR-1930**
2000 - 2200	1000 - 1100	+10	12.0	25	25	30	102	1	**HSMR-2000**
2200 - 2500	1100 - 1250	+10	12.0	25	25	30	102	1	**HSMR-2250**

LEADLESS SURFACE-MOUNT MODELS



RF OUTPUT FREQUENCY (MHz)	CARRIER FREQUENCY (MHz)	NOMINAL CARRIER POWER (dBm)	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	CARRIER REJECTION (dB) MIN	HARMONIC REJECTION (dB) MIN	PACKAGE	PIN-OUT (See Below)	MODEL
810 - 830	405 - 415	+10	11.0	30	30	33	161	2	**HSMD-810**
825 - 875	412 - 438	+10	11.0	30	30	33	161	2	**HSMD-825**
869 - 894	434 - 447	+10	11.0	30	30	33	161	2	**HSMD-869**
935 - 970	467 - 485	+10	11.0	30	30	33	161	2	**HSMD-935**
1000 - 1070	500 - 535	+10	11.0	30	30	33	161	2	**HSMD-1000**
1200 - 1280	600 - 640	+10	11.0	30	30	33	161	2	**HSMD-1200**
1400 - 1500	700 - 750	+10	11.0	30	30	33	161	2	**HSMD-1400**
1500 - 1650	750 - 825	+10	11.0	30	30	33	161	2	**HSMD-1500**
1800 - 1900	900 - 950	+10	12.0	25	25	30	161	2	**HSMD-1800**
1805 - 1880	902 - 940	+10	12.0	25	25	30	161	2	**HSMD-1805**
1920 - 2000	960 - 1000	+10	12.0	25	25	30	161	2	**HSMD-1930**
2000 - 2200	1000 - 1100	+10	12.0	25	25	30	161	2	**HSMD-2000**
2200 - 2500	1100 - 1250	+10	12.0	25	25	30	161	2	**HSMD-2250**

Notes:
- USB is suppressed when MOD.1 is +90° ref to MOD. 2.
- LSB is suppressed when MOD.1 is -90° ref to MOD. 2.
- 1 dB Comp. Point: -5 dBm (Nom)
- Modulation Frequency = DC to 20 MHz
- Harmonic and Carrier rejection is guaranteed with -10 dBm input at MOD. 1 and MOD. 2.
- Conversion Loss is the difference between total power of both modulation inputs and desired sideband output.

This product is protected under United States Patent Number 5,416,449.

PIN-OUT TABLE

	CARRIER	MOD.1	MOD.2	SSB OUTPUT	CASE GND
#1	8	3	4	1	All Other
#2	3	1	4	2	All Other

For pin location and package outline drawings, see back pages.

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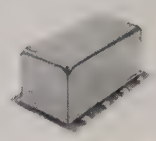
I&Q DEMODULATORS



Leadless Surface-Mount Models

FREQUENCY (MHz) LO	RF	IF	LO LEVEL (dBm) NOM	CONVERSION LOSS♦ (dB) MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) LO/RF MIN	LO/IF MIN	VSWR MAX	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
19-21	10-30	DC-10	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102S	1	**QMS-201**
28.5-31.5	15-45	DC-15	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102S	1	**QMS-202**
38-42	20-60	DC-20	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102S	1	**QMS-203**
52-88	52-88	DC-35	+10	7.0	0.2/0.5	2.0/4.0	40	35	1.5:1	+3	+15	102S	1	**QMS-210**
57-63	30-90	DC-30	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102S	1	**QMS-204**
66.5-73.5	35-105	DC-35	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102S	1	**QMS-205**
80-160	80-160	DC-40	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	102S	1	**QMS-206**
100-200	100-200	DC-50	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	102S	1	**QMS-207**
810-830	810-830	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102S	1	**QMS-214**
850-950	850-950	DC-100	+10	8.0	0.8/1.3	3.0/6.0	35	30	1.8:1	+3	+15	102S	1	**QMS-213**
869-894	869-894	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102S	1	**QMS-224**
935-960	935-960	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102S	1	**QMS-234**
1805-1880	1805-1880	DC-50	+10	8.0	0.8/1.2	2.0/6.0	25	20	2.0:1	+3	+15	102S	1	**QMS-244**

♦ Conversion loss = RF input power (dBm) minus IF1 and IF2 power (dBm).

Notes:

IF_1 is +90° ref to IF_2 when RF < LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	1	8	3	4	All Other

For pin location and package outline drawings, see back pages.

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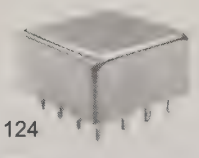
THROUGH-HOLE MOUNT

8 PIN - RELAY CAN

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS♦ (dB)	AMPLITUDE UNBALANCE (dB)	PHASE UNBALANCE (Degrees)	ISOLATION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	MAX	TYP/MAX	TYP/MAX	LO/RF MIN	LO/IF MIN	MAX	MIN	TYP			
19-21	10-30	DC-10	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102	1	QMR-201
28.5-31.5	15-45	DC-15	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102	1	QMR-202
38-42	20-60	DC-20	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102	1	QMR-203
57-63	30-90	DC-30	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102	1	QMR-204
66.5-73.5	35-105	DC-35	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	102	1	QMR-205
80-160	80-160	DC-40	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	102	1	QMR-206
100-200	100-200	DC-50	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	102	1	QMR-207
810-830	810-830	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102	1	QMR-214
869-894	869-894	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102	1	QMR-224
935-960	935-960	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	102	1	QMR-234
1805-1880	1805-1880	DC-50	+10	8.0	0.8/1.2	2.0/6.0	25	20	2.0:1	+3	+15	102	1	QMR-244

6 PIN (Wideband) AND 16 PIN



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FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS♦ (dB)	AMPLITUDE UNBALANCE (dB)	PHASE UNBALANCE (Degrees)	ISOLATION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	MAX	TYP/MAX	TYP/MAX	LO/RF MIN	LO/IF MIN	MAX	MIN	TYP			
15-50	15-50	DC-10	+10	7.0	0.3/0.5	2.0/5.0	40	35	1.5:1	+3	+15	151	3	QMP-15-50
15-510	15-510	DC-250	+10	7.0	0.7/1.5	5.0/10	35	20	2.0:1	+3	+15	151	3	QMP-34-15
19-21	10-30	DC-10	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	124	2	QMP-901
28.5-31.5	15-45	DC-15	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	124	2	QMP-902
38-42	20-60	DC-20	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	124	2	QMP-903
57-63	30-90	DC-30	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	124	2	QMP-904
66.5-73.5	35-105	DC-35	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	124	2	QMP-905
80-160	80-160	DC-40	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	124	2	QMP-906
100-200	100-200	DC-50	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	124	2	QMP-907
810-830	810-830	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	124	2	QMP-914
869-894	869-894	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	124	2	QMP-924
935-960	935-960	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	124	2	QMP-934
1805-1880	1805-1880	DC-50	+10	8.0	0.8/1.2	2.0/6.0	25	20	2.0:1	+3	+15	124	2	QMP-944

Notes:

IF_1 is +90° ref to IF_2 when RF < LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	1	8	3	4	All Other
#2	1	16	4	13	All Other
#3	1	6	3	2	4,5

♦ Conversion loss = RF input power (dBm) minus IF1 and IF2 power (dBm).

For pin location and package outline drawings, see back pages.

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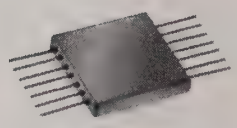
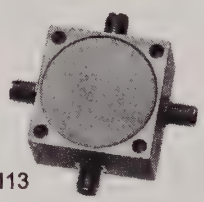


FLAT PACK MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS♦ (dB)	AMPLITUDE UNBALANCE (dB)	PHASE UNBALANCE (Degrees)	ISOLATION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	MAX	TYP/MAX	TYP/MAX	LO/RF MIN	LO/IF MIN	MAX	MIN	TYP			
19-21	10-30	DC-10	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	115	1	QMF-201
28.5-31.5	15-45	DC-15	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	115	1	QMF-202
38-42	20-60	DC-20	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	115	1	QMF-203
57-63	30-90	DC-30	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	115	1	QMF-204
66.5-73.5	35-105	DC-35	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	115	1	QMF-205
80-160	80-160	DC-40	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	115	1	QMF-206
100-200	100-200	DC-50	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	115	1	QMF-207
810-830	810-830	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	115	1	QMF-214
869-894	869-894	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	115	1	QMF-224
935-960	935-960	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	115	1	QMF-234
1805-1880	1805-1880	DC-50	+10	8.0	0.8/1.2	2.0/6.0	25	20	2.0:1	+3	+15	115	1	QMF-244



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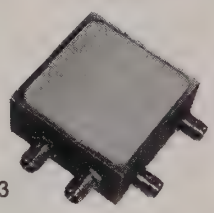

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COAXIAL CONNECTOR MODELS

FREQUENCY (MHz)			LO LEVEL (dBm)	CONVERSION LOSS♦ (dB)	AMPLITUDE UNBALANCE (dB)	PHASE UNBALANCE (Degrees)	ISOLATION (dB)		VSWR	INPUT 1 dB COMP. PT. (dBm)	INPUT IP_3 (dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
LO	RF	IF	NOM	MAX	TYP/MAX	TYP/MAX	LO/RF MIN	LO/IF MIN	MAX	MIN	TYP			
15-510	15-510	DC-250	+10	7.0	0.7/1.5	5.0/10	35	20	2.0:1	+3	+15	153	3	QMK-34-15
19-21	10-30	DC-10	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	113	2	QMK-701*
28.5-31.5	15-45	DC-15	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	113	2	QMK-702*
38-42	20-60	DC-20	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	113	2	QMK-703*
57-63	30-90	DC-30	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	113	2	QMK-704*
66.5-73.5	35-105	DC-35	+10	7.0	0.2/0.4	1.0/2.0	40	35	1.5:1	+3	+15	113	2	QMK-705*
80-160	80-160	DC-40	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	113	2	QMK-706*
100-200	100-200	DC-50	+10	8.0	0.6/1.0	1.0/3.0	35	30	1.5:1	+3	+15	113	2	QMK-707*
810-830	810-830	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	113	2	QMK-714*
869-894	869-894	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	113	2	QMK-724*
935-960	935-960	DC-50	+10	8.0	0.6/1.0	1.0/4.0	35	30	1.8:1	+3	+15	113	2	QMK-734*
1805-1880	1805-1880	DC-50	+10	8.0	0.8/1.2	2.0/6.0	25	20	2.0:1	+3	+15	113	2	QMK-744*
2450	2400-2500	DC-100	+10	7.0	0.3/0.5	2.0/5.0	17	20	2.0:1	+2	+13	153	2	QMK2450A
3410-3590	3410-3590	DC-100	+10	9.0	0.5/1.0	3.0/6.0	17	10	2.0:1	+2	+13	153	2	QMK2490A

Notes:

IF_1 is +90° ref to IF_2 when RF < LO frequency.
Nominal impedance = 50 ohms.
Maximum RF input power without damage 200 mW.

*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC.
All other models numbers are available with SMA connectors only.

♦ Conversion loss = RF input power (dBm) minus IF1 and IF2 power (dBm).

PIN-OUT TABLE

	RF	LO	IF_1	IF_2	CASE GND
#1	14	1	10	5	All Other
#2	3	1	2	4	-

For pin location and package outline drawings, see back pages.

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I&Q MODULATORS

103S

102S

LEADLESS SURFACE-MOUNT

CARRIER FREQUENCY (MHz)	MODULATION FREQUENCY (MHz)	CARRIER POWER (dBm) NOM	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	LO/RF ISOLATION (dB) MIN	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
28.5 - 31.5	DC-15	+10	8.0	30	45	0	+15	102S	1	**SMS-201**
57 - 63	DC-30	+10	8.0	30	45	0	+15	102S	1	**SMS-202**
66.5 - 73.5	DC-35	+10	8.0	30	45	0	+15	102S	1	**SMS-203**
40 - 80	DC-40	+10	8.0	30	45	0	+15	102S	1	**SMS-204**
80 - 160	DC-80	+10	8.0	30	45	0	+15	102S	1	**SMS-205**
100 - 200	DC-100	+10	8.0	30	45	0	+15	102S	1	**SMS-206**
150 - 165	DC-20	+26	8.0	35	65	+20	+30	103S	1	**SMS-1506**
165	DC-5.0	+17	8.0	40	65	+8.0	+20	103S	1	**SMS-1650**
220	DC-10	+13	8.0	40	60	+6.0	+18	103S	1	**SMS-2206**
810 - 830	DC-40	+10	8.5	30	35	0	+15	102S	1	**SMS-214**
869 - 894	DC-80	+10	8.5	30	35	0	+15	102S	1	**SMS-224**
935 - 960	DC-100	+10	8.5	30	35	0	+15	102S	1	**SMS-234**
1805 - 1880	DC-100	+10	8.5	25	25	0	+15	102S	1	**SMS-244**

Notes:
- SSB rejection based on optimum input quadrature signals.
- Conversion Loss is the difference between total power of both modulation inputs, and desired sideband output.
- USB is suppressed when MOD.1 is +90° ref to MOD.2.
- LSB is suppressed when MOD.1 is -90° ref to MOD.2.
- Nominal impedance = 50 ohms.
- Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	CARRIER	OUTPUT	MOD_1	MOD_2	CASE GND
#1	8	1	3	4	All Other

For pin location and package outline drawings, see back pages.

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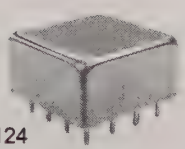
I&Q MODULATORS

THROUGH HOLE MODELS

8 PIN - RELAY HEADER

CARRIER FREQUENCY (MHz)	MODULATION FREQUENCY (MHz)	CARRIER POWER (dBm) NOM	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	LO/RF ISOLATION (dB) MIN	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
28.5 - 31.5	DC-15	+10	8.0	30	45	0	+15	102	1	**SMR-201**
57 - 63	DC-30	+10	8.0	30	45	0	+15	102	1	**SMR-202**
66.5 - 73.5	DC-35	+10	8.0	30	45	0	+15	102	1	**SMR-203**
40 - 80	DC-40	+10	8.0	30	45	0	+15	102	1	**SMR-204**
80 - 160	DC-80	+10	8.0	30	45	0	+15	102	1	**SMR-205**
100 - 200	DC-100	+10	8.0	30	45	0	+15	102	1	**SMR-206**
810 - 830	DC-40	+10	8.5	30	35	0	+15	102	1	**SMR-214**
869 - 894	DC-80	+10	8.5	30	35	0	+15	102	1	**SMR-224**
935 - 960	DC-100	+10	8.5	30	35	0	+15	102	1	**SMR-234**
1805 - 1880	DC-100	+10	8.5	25	25	0	+15	102	1	**SMR-244**

PLUG-IN (6 PIN (WIDEBAND) AND 16 PIN)



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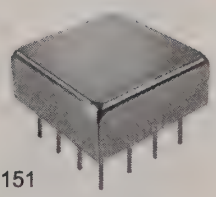

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CARRIER FREQUENCY (MHz)	MODULATION FREQUENCY (MHz)	CARRIER POWER (dBm) NOM	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	LO/RF ISOLATION (dB) MIN	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
15 - 510	DC-250	+10	9.0	15	35	0	+15	151	3	**SMP-34-15**
28.5 - 31.5	DC-15	+10	8.0	30	45	0	+15	124	2	**SMP-901**
57 - 63	DC-30	+10	8.0	30	45	0	+15	124	2	**SMP-902**
66.5 - 73.5	DC-35	+10	8.0	30	45	0	+15	124	2	**SMP-903**
40 - 80	DC-40	+10	8.0	30	45	0	+15	124	2	**SMP-904**
80 - 160	DC-80	+10	8.0	30	45	0	+15	124	2	**SMP-905**
100 - 200	DC-100	+10	8.0	30	45	0	+15	124	2	**SMP-906**
275 - 550	DC-10	+10	8.5	15	35	0	+15	124	2	**SMP-907**
810 - 830	DC-40	+10	8.5	30	35	0	+15	124	2	**SMP-914**
869 - 894	DC-80	+10	8.5	30	35	0	+15	124	2	**SMP-924**
935 - 960	DC-100	+10	8.5	30	35	0	+15	124	2	**SMP-934**
1805 - 1880	DC-100	+10	8.5	25	25	0	+15	124	2	**SMP-944**

Notes:
- SSB rejection based on optimum input quadrature signals.
- Conversion Loss is the difference between total power of both modulation inputs, and desired sideband output.
- USB is suppressed when MOD.1 is +90° ref to MOD.2.
- LSB is suppressed when MOD.1 is -90° ref to MOD.2.
- Nominal impedance = 50 ohms.
- Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	CARRIER	OUTPUT	MOD_1	MOD_2	CASE GND
#1	8	1	3	4	All other
#2	16	1	4	13	All other
#3	6	1	3	2	4,5

For pin location and package outline drawings, see back pages.

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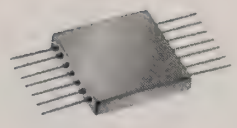
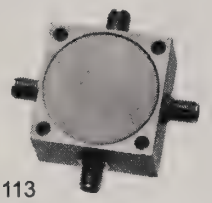


FLAT PACK MODELS

CARRIER FREQUENCY (MHz)	MODULATION FREQUENCY (MHz)	CARRIER POWER (dBm) NOM	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	LO/RF ISOLATION (dB) MIN	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
28.5 - 31.5	DC-15	+10	8.0	30	45	0	+15	115	1	**SMF-201**
57 - 63	DC-30	+10	8.0	30	45	0	+15	115	1	**SMF-202**
66.5 - 73.5	DC-35	+10	8.0	30	45	0	+15	115	1	**SMF-203**
40 - 80	DC-40	+10	8.0	30	45	0	+15	115	1	**SMF-204**
80 - 160	DC-80	+10	8.0	30	45	0	+15	115	1	**SMF-205**
100 - 200	DC-100	+10	8.0	30	45	0	+15	115	1	**SMF-206**



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COAXIAL (SMA) CONNECTOR MODELS

CARRIER FREQUENCY (MHz)	MODULATION FREQUENCY (MHz)	CARRIER POWER (dBm) NOM	CONVERSION LOSS (dB) MAX	SSB REJECTION (dB) MIN	LO/RF ISOLATION (dB) MIN	INPUT 1 dB COMP. PT. (dBm) MIN	INPUT IP_3 (dBm) TYP	PACKAGE	PIN-OUT (See Below)	MODEL
15 - 510	DC-250	+10	9.0	15	35	0	+15	153	2	**SMK-34-15**
28.5 - 31.5	DC-15	+10	8.0	30	45	0	+15	113	2	**SMK-701***
57 - 63	DC-30	+10	8.0	30	45	0	+15	113	2	**SMK-702***
66.5 - 73.5	DC-35	+10	8.0	30	45	0	+15	113	2	**SMK-703***
40 - 80	DC-40	+10	8.0	30	45	0	+15	113	2	**SMK-704***
80 - 160	DC-80	+10	8.0	30	45	0	+15	113	2	**SMK-705***
100 - 200	DC-100	+10	8.0	30	45	0	+15	113	2	**SMK-706***

*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC.
All other models numbers are available with SMA connectors only.

Notes:
- SSB rejection based on optimum input quadrature signals.
- Conversion Loss is the difference between total power of both modulation inputs, and desired sideband output.
- USB is suppressed when MOD.1 is +90° ref to MOD.2.
- LSB is suppressed when MOD.1 is -90° ref to MOD.2.
- Nominal impedance = 50 ohms.
- Maximum RF input power without damage 200 mW.

PIN-OUT TABLE

	CARRIER	OUTPUT	MOD_1	MOD_2	CASE GND
#1	1	14	10	5	All Other
#2	1	3	2	4	-

For pin location and package outline drawings, see back pages.

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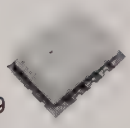
BPSK MODULATORS

SURFACE-MOUNT MODELS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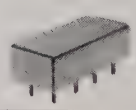
INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 200	3.5/4.5	0.4	4.0	+ 1	1.8:1	134	1	**SBM-K1**
2 - 600	4.5/5.5	0.4	4.0	+ 1	1.8:1	134	1	**SBM-K2**
1 - 200	2.5/4.5	0.4	2.0	+ 1	2.0:1	129	2	**SBM-C1**
2 - 600	2.5/4.5	0.4	2.0	+ 1	2.0:1	129	2	**SBM-C2**

THROUGH HOLE MODELS

8 PIN - RELAY CAN



INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 400	1.5/3.0	0.2	2.0	+ 1	1.5:1	103	3	**MP-205**
1 - 400	1.5/3.0	0.2	2.0	+ 10	1.5:1	103	3	**MP-215**
10 - 900	2.5/4.5	0.4	2.0	+ 1	2.0:1	103	3	**MP-207**
10 - 900	2.5/4.5	0.4	2.0	+ 10	2.0:1	103	3	**MP-217**

TO-8 (12 PIN)

INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 400	1.5/3.0	0.2	2.0	+ 1	1.5:1	104	4	**MP-201**
1 - 400	1.5/3.0	0.2	2.0	+ 10	1.5:1	104	4	**MP-211**
10 - 900	2.5/4.5	0.4	2.0	+ 1	2.0:1	104	4	**MP-203**
10 - 900	2.5/4.5	0.4	2.0	+ 10	2.0:1	104	4	**MP-213**

Notes:
Logic 1 corresponds to +20 mA and Logic 0 corresponds to -20 mA.
Nominal input/output impedance = 50 ohms.
Maximum RF input power without damage 75 mW or 40 mA.

PIN-OUT TABLE

	INPUT	OUTPUT	D1	D2	CASE GND	NO CONN.
#1	1	4	5	2	3,6	
#2	1	3	6	4	7,8,9,10	2,5
#3	8	1	*3,4	*5,6	2,7	
#4	11	8	2	5	All other	

For pin location and package outline drawings, see back pages.
*Connect pins together externally.

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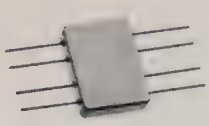
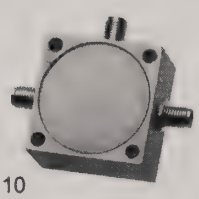
BPSK MODULATORS

FLAT PACK MODELS



INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 400	1.5/3.0	0.2	2.0	+ 1	1.5:1	101	1	**MF-206**
1 - 400	1.5/3.0	0.2	2.0	+ 10	1.5:1	101	1	**MF-216**
10 - 900	2.5/4.5	0.4	2.0	+ 1	2.0:1	101	1	**MF-208**
10 - 900	2.5/4.5	0.4	2.0	+ 10	2.0:1	101	1	**MF-218**
40 - 1150	3.9/4.5	0.4	4.0	+ 1	3.0:1	101	2	**MF-210♦**
40 - 1150	3.9/4.5	0.4	4.0	+ 10	3.0:1	101	2	**MF-220♦**

COAXIAL (SMA) CONNECTOR MODELS



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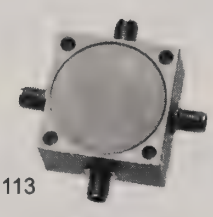

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INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 400	1.5/3.0	0.2	2.0	+ 1	1.5:1	113	3	**MK-701S**
1 - 400	1.5/3.0	0.2	2.0	+ 10	1.5:1	113	3	**MK-711S**
10 - 900	2.5/4.5	0.4	2.0	+ 1	2.0:1	113	3	**MK-702S**
10 - 900	2.5/4.5	0.4	2.0	+ 10	2.0:1	113	3	**MK-712S**
40 - 1150	3.9/4.5	0.4	4.0	+ 1	3.0:1	110	4	**MK-703S♦**
40 - 1150	3.9/4.5	0.4	4.0	+ 10	3.0:1	110	4	**MK-713S♦**

♦ Require external bipolar squarewave driver capable of generating +/-20 mA .

Notes:
Logic 1 corresponds to +20 mA and Logic 0 corresponds to -20 mA.
Nominal input/output impedance = 50 ohms.
Maximum RF input power without damage 75 mW or 40 mA.

PIN-OUT TABLE

	INPUT	OUTPUT	D1	D2	CASE GND
#1	4	1	5	8	2,3,6,7
#2	4	1	5	-	2,3,6,7,8
#3	1	3	2	4	
#4	1	3	2	-	

For pin location and package outline drawings, see back pages.

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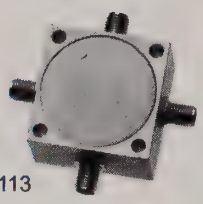
QPSK MODULATORS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COAXIAL CONNECTOR MODELS

INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) Fc MAX	PHASE UNBALANCE (Degrees) FULL BAND MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
15 - 510	11.0	1.5	10	10	+4	2.5:1	153	1	**MK-34-15**
28.5 - 31.5	7.0	0.4	2.0	3.5	+4	1.7:1	113	1	**MK-751***
52 - 88	8.0	1.0	2.0	5.0	+4	1.7:1	113	1	**MK-757***
57 - 63	7.0	0.4	2.0	3.5	+4	1.7:1	113	1	**MK-753***
66.5 - 73.5	7.0	0.4	2.0	3.5	+4	1.7:1	113	1	**MK-755***
104 - 176	8.0	1.0	2.0	5.0	+4	1.7:1	113	1	**MK-758***
133 - 147	7.0	0.4	2.0	3.5	+4	1.7:1	113	1	**MK-756***
190 - 210	7.0	0.4	2.0	3.5	+4	1.7:1	113	1	**MK-759***
285 - 315	7.5	0.4	2.0	5.0	+4	1.7:1	113	1	**MK-760***
810 - 830	8.0	0.6	4.0	5.0	+4	2.0:1	113	1	**MK-714S**
869 - 894	8.5	0.6	4.0	5.0	+4	2.0:1	113	1	**MK-724S**
935 - 960	8.0	0.6	4.0	5.0	+4	2.0:1	113	1	**MK-734S**
1805 - 1880	9.5	1.0	6.0	7.0	+4	2.2:1	113	1	**MK-736S**

Notes:
Logic 1 corresponds to +20 mA and Logic 0 corresponds to -20 mA.
Requires external bipolar squarewave driver capable of generating +/-20 mA to drive D1 and D3.
Nominal input/output impedance = 50 ohms.
Maximum RF input power without damage 200 mW and 40 mA at D1 and D3.

*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC.
All other models numbers are available with SMA connectors only.

PIN-OUT TABLE

	CARRIER	OUTPUT	D1	D3
#1	1	3	2	4

For pin location and package outline drawings, see back pages.

LOGIC TABLE

PHASE	D1	D3
0°	1	1
90°	1	0
180°	0	0
270°	0	1

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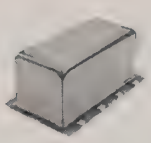
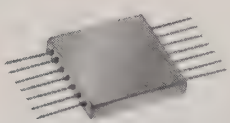
QPSK MODULATORS



SURFACE-MOUNT MODELS

INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) Fc MAX	PHASE UNBALANCE (Degrees) FULL BAND MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10.165 - 11.235	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-202**
20.33 - 22.47	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-204**
28.5 - 31.5	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-201**
52 - 88	8.0	1.0	2.0	5.0	+4	1.7:1	102S	1	**MS-207**
57 - 63	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-203**
66.5 - 73.5	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-205**
104 - 176	8.0	1.0	2.0	5.0	+4	1.7:1	102S	1	**MS-208**
133 - 147	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-206**
190 - 210	7.0	0.4	2.0	3.5	+4	1.7:1	102S	1	**MS-209**
285 - 315	7.5	0.4	2.0	5.0	+4	1.7:1	102S	1	**MS-210**
810 - 830	8.0	0.6	4.0	5.0	+4	2.0:1	102S	1	**MS-214**
869 - 894	8.5	0.6	4.0	5.0	+4	2.0:1	102S	1	**MS-224**
935 - 960	8.0	0.6	4.0	5.0	+4	2.0:1	102S	1	**MS-234**
805 - 1880	9.5	1.0	6.0	7.0	+4	2.2:1	102S	1	**MS-236**



FLAT PACK MODELS

INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) Fc MAX	PHASE UNBALANCE (Degrees) FULL BAND MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
28.5 - 31.5	7.0	0.4	2.0	3.5	+4	1.7:1	115	2	**MF-111**
52 - 88	8.0	1.0	2.0	5.0	+4	1.7:1	115	2	**MF-117**
57 - 63	7.0	0.4	2.0	3.5	+4	1.7:1	115	2	**MF-113**
66.5 - 73.5	7.0	0.4	2.0	3.5	+4	1.7:1	115	2	**MF-115**
104 - 176	8.0	1.0	2.0	5.0	+4	1.7:1	115	2	**MF-118**
133 - 147	7.0	0.4	2.0	3.5	+4	1.7:1	115	2	**MF-116**
190 - 210	7.0	0.4	2.0	3.5	+4	1.7:1	115	2	**MF-119**
285 - 315	7.5	0.4	2.0	5.0	+4	1.7:1	115	2	**MF-120**

Notes:
Logic 1 corresponds to +20 mA and Logic 0 corresponds to -20 mA.
Above models do not include Logic complimentary drivers.
Nominal input/output impedance = 50 ohms.
Maximum RF input power without damage 200 mW and 40 mA.

PIN-OUT TABLE

	CARRIER	OUTPUT	D1	D2	D3	D4	CASE GND
#1	8	1	3	5	4	6	2,7
#2	1	14	5	3	12	10	All Other

For pin location and package outline drawings, see back pages.

LOGIC TABLE

PHASE	D1	D2	D3	D4
0°	1	0	1	0
90°	1	0	0	1
180°	0	1	0	1
270°	0	1	1	0

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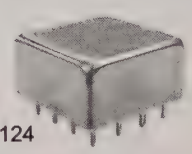
QPSK MODULATORS

THROUGH-HOLE

8 PIN - RELAY CAN

INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) Fc MAX	PHASE UNBALANCE (Degrees) FULL BAND MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10.165 - 11.235	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-202**
20.33 - 22.47	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-204**
28.5 - 31.5	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-201**
52 - 88	8.0	1.0	2.0	5.0	+4	1.7:1	102	1	**MR-207**
57 - 63	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-203**
66.5 - 73.5	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-205**
104 - 176	8.0	1.0	2.0	5.0	+4	1.7:1	102	1	**MR-208**
133 - 147	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-206**
190 - 210	7.0	0.4	2.0	3.5	+4	1.7:1	102	1	**MR-209**
285 - 315	7.5	0.4	2.0	5.0	+4	1.7:1	102	1	**MR-210**
810 - 830	8.0	0.6	4.0	5.0	+4	2.0:1	102	1	**MR-214**
869 - 894	8.5	0.6	4.0	5.0	+4	2.0:1	102	1	**MR-224**
935 - 960	8.0	0.6	4.0	5.0	+4	2.0:1	102	1	**MR-234**
1805 - 1880	9.5	1.0	6.0	7.0	+4	2.2:1	102	1	**MR-236**

PLUG-IN 6 PIN (Wideband) AND 16 PIN



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INPUT CARRIER FREQUENCY (MHz)	INSERTION LOSS (dB) MAX	AMPLITUDE UNBALANCE (dB) MAX	PHASE UNBALANCE (Degrees) Fc MAX	PHASE UNBALANCE (Degrees) FULL BAND MAX	INPUT 1 dB COMP. PT. (dBm) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
15 - 510	11.0	1.5	10	10	+4	2.5:1	151	3	***MP-34-15**
28.5 - 31.5	7.0	0.4	2.0	3.5	+4	1.7:1	124	2	**MP-901**
52 - 88	8.0	1.0	2.0	5.0	+4	1.7:1	124	2	**MP-907**
57 - 63	7.0	0.4	2.0	3.5	+4	1.7:1	124	2	**MP-903**
66.5 - 73.5	7.0	0.4	2.0	3.5	+4	1.7:1	124	2	**MP-905**
104 - 176	8.0	1.0	2.0	5.0	+4	1.7:1	124	2	**MP-908**
133 - 147	7.0	0.4	2.0	3.5	+4	1.7:1	124	2	**MP-906**
190 - 210	7.0	0.4	2.0	3.5	+4	1.7:1	124	2	**MP-909**
285 - 315	7.5	0.4	2.0	5.0	+4	1.7:1	124	2	**MP-910**
810 - 830	8.0	0.6	4.0	5.0	+4	2.0:1	124	2	**MP-914**
869 - 894	8.5	0.6	4.0	5.0	+4	2.0:1	124	2	**MP-924**
935 - 960	8.0	0.6	4.0	5.0	+4	2.0:1	124	2	**MP-934**
1805 - 1880	9.5	1.0	6.0	7.0	+4	2.2:1	124	2	**MP-936**

Notes:
Logic 1 corresponds to +20 mA and Logic 0 corresponds to -20 mA.
Above models do not include Logic complimentary drivers.
Nominal input/output impedance = 50 ohms.
Maximum RF input power without damage 200 mW and 40 mA.
The logic table for the MP-34-15 is the same as for the coaxial connector models.

LOGIC TABLE

PHASE	D1	D2	D3	D4
0°	1	0	1	0
90°	1	0	0	1
180°	0	1	0	1
270°	0	1	1	0

PIN-OUT TABLE

	CARRIER	OUTPUT	D1	D2	D3	D4	CASE GND
#1	8	1	3	5	4	6	2,7
#2	16	1	13	5	3	4	All Other
#3	6	1	3	-	2	-	4,5

For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

POWER DIVIDERS AND COMBINERS

There are several classes of devices that can be used to divide or combine RF/Microwave power. Generally, they are classitied according to the number of output ports and the relative phase difference between the output signals. The appropriate device must be carefully selected based on the device type and specifications. Particular care must be taken in specifying devices where the application calls for power combining.

The following is a description of the key characteristics normally used in specifying Power Divider performance, and the various types of Power Dividers available.

PARAMETER DEFINITIONS

Insertion Loss

Insertion loss is, simply, the difference in excess of the theoretical splitting loss (in dB) between the amplitude of any output signal and the amplitude of the input signal. The theoretical splitting loss is 3 dB for 2-way dividers, 6 dB for 4-way dividers, 9 dB for 8-way, etc.

Amplitude Balance

Amplitude Balance (in dB) refers to the maximum amplitude difference between any two output signals.

Phase Balance

Phase Balance (in degrees) refers to the maximum phase deviation from theoretical, measured betweenany two output signals (i.e., net phase difference in an in-phase device, net phase difference less 90 degrees in a quadrature device, etc.)

Isolation

Isolation (in dB), in a Power Divider, is defined as the attenuation between a signal present at any Output port and its level as measured at any other Output port, with the input port terminated in 50 ohms. This is a critical parameter that allows the design engineer to estimate "crosstalk" between the various outputs.

Internal Power Dissipation

Internal Power Dissipation is simply the power rating of the internal terminations. When the Power Divider is utilized in the recommended manner, these ratings would not be exceeded. However, some system configurations may allow, for example, the possibility of various outputs being disconnected. In this case, high power levels are "dumped" across the internal terminations. Obviously, in this case, care should be taken with respect to the Internal Power Dissipation rating.

DEVICE TYPES

In Phase: N-way Dividers

These devices deliver output signals in-phase with each other. The most common types are 2-, 4-, 8-, and 16-way dividers. Odd-numbered power division circuits, by design, have a narrower bandwidth. The following table contains number of output and corresponding coupling loss.

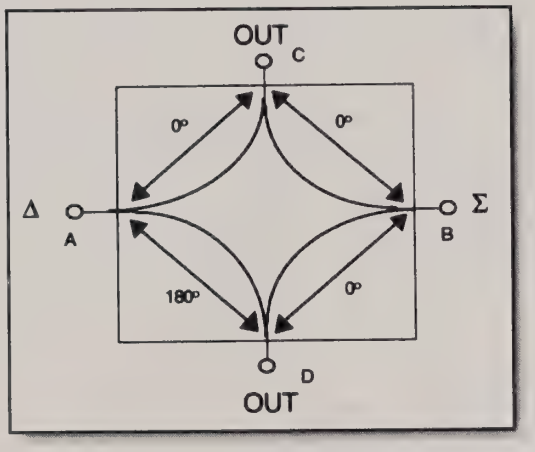
No. of output (N)	Coupling Loss (dB)
2	3.01
3	4.77
4	6.02
5	7.00
6	7.78
8	9.03
10	10.0
12	10.8

Extreme caution must be used when combining signals. Proper combining requires that all signals have the same frequency phase, and amplitude. If dissimilar signals are combined, make sure that the resistors used are capable of handling the required power.

180 Degree Hybrids

A 180 degree hybrid is a 4 port device which provides two (C&D) equal amplitude in phase signals when fed from its sum port (Σ), and two (C&D) equal amplitude 180 degrees out of phase signals when fed from its difference port (Δ).

If port B is terminated, then the 180 degree hybrid becomes a 3 port device.



90 Degree (Quadrature) Hybrids

These devices split or combine in quadrature (one output signal being 90 degrees out of phase with theother), and have many uses in signal processing. Even though they are reciprocal devices, the same care must be taken in combiner applications as with in-phase combiners. Bandwidth is the most important limitation of the quadrature ("quad") hybrid. "Crossover" quads have a bandwidth of 10% and can be manufactured to have excellent amplitude and phase balance as well as low loss, high isolation, and good VSWR. They are very useful for processing signal frequencies and their applications are numerous.

Synergy's Quadrature Hybrids are available in bandwidths of 10%, octave, 3:1, 5:1, and 10:1 in various package styles.

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POWER DIVIDERS

0° : 2-WAY

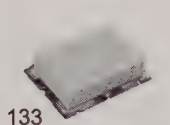
LEADLESS SURFACE-MOUNT

133

134

147

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.1 - 100	25/20	25/22	23/20	0.2/0.4	.25/0.6	0.4/1.0	2.0	2.0	2.0	0.2	0.2	0.2	133	3	**SPD-C2**
1 - 500	35/25	32/25	30/20	0.3/0.6	.35/0.7	0.6/1.0	2.0	3.0	4.0	0.2	0.3	0.3	133	3	**SPD-C1**
2 - 300	25/20	30/20	25/20	0.5/0.9	0.6/0.8	0.8/1.0	3.0	4.0	5.0	0.4	0.5	0.5	134	1	**SD-1**
5 - 500	25/20	30/20	25/20	0.4/0.7	0.5/0.8	0.6/1.0	3.0	4.0	5.0	0.4	0.4	0.6	134	2	**SD-2**
10 - 1000	25/20	30/17	25/17	0.5/0.8	0.6/1.0	1.0/1.5	2.0	4.0	7.0	0.4	0.5	0.7	134	2	**SD-3**
10 - 1000	25/20	30/20	25/17	0.5/0.8	0.6/1.0	1.0/1.5	2.0	4.0	7.0	0.4	0.5	0.7	147	4	**SPD-M-3**
10 - 1000	22/19	19/17	18/15	0.4/0.8	0.7/1.2	1.2/1.5	2.0	3.0	5.0	0.2	0.3	0.5	133	3	**SPD-C5**
500 - 1500	20/15	20/15	20/15	0.6/0.8	0.7/0.8	0.8/1.0	3.0	4.0	5.0	0.3	0.4	0.5	133	3	**SPD-C4**
700 - 1000	20/15	20/15	20/15	0.6/0.8	0.6/0.8	0.8/1.0	3.0	4.0	5.0	0.3	0.4	0.5	133	3	**SPD-C3**
850 - 960	-/-	-/-	27/20	-/-	-/-	0.6/1.0	-/-	-/-	5.0	-/-	-/-	0.4	133	3	**SPD-C1-2♦**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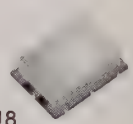
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124S

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1600 - 1700	-/-	-/-	26/21	-/-	-/-	0.8/1.2	-/-	-/-	3.0	-/-	-/-	0.6	133	3	**SPD-C7♦**
1600-1900	-/-	-/-	24/18	-/-	-/-	0.3/0.5	--	--	2.0	--	--	0.2	218	6	**SPD-C10♦**
1725 - 1900	-/-	-/-	25/20	-/-	-/-	0.4/0.6	-/-	-/-	4.0	-/-	-/-	0.4	124S	5	**DSS-927♦**
2000 - 2100	-/-	-/-	26/21	-/-	-/-	0.4/0.6	-/-	-/-	3.0	-/-	-/-	0.6	133	3	**SPD-C8♦**
2000 - 2200	-/-	-/-	25/20	-/-	-/-	0.8/1.2	-/-	-/-	3.0	-/-	-/-	0.6	124S	5	**DSS-928♦**
2200 - 2400	-/-	-/-	25/20	-/-	-/-	0.8/1.2	-/-	-/-	3.0	-/-	-/-	0.6	124S	5	**DSS-929♦**

Notes: ■ 75 Ohm Model
Power Rating(All Models) = 1 watt, max
♦ LB = 500-700 MHz, MB = 750-1000 MHz, UB = 1000-1500 Mhz
♦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	*GROUND
#1	2	4,6	1,3,5
#2	6	3,4	1,2,5
#3	3	1,2	4,5,6
#4	1	2,4	3
#5	1	4,16	All other
#6	1	2,3	All other

*GROUND = Ground externally

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SYNERGY® MICROWAVE CORPORATION

POWER DIVIDERS

0° : 2-WAY

LEADED SURFACE-MOUNT

134S

159

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
2 - 300	25/20	30/20	25/20	0.5/0.9	0.6/0.8	0.8/1.0	3.0	4.0	5.0	0.4	0.5	0.5	159	1	**SDL-1**
2 - 500	35/18	35/25	27/20	0.3/0.8	0.3/0.6	0.5/1.0	1.0	2.0	3.0	0.15	0.2	0.3	159	2	**SDL-173** ■
2 - 1000	35/25	27/17	23/17	0.5/0.6	0.7/0.9	1.2/1.5	1.0	2.0	4.0	0.2	0.3	0.6	159	2	**SDL-100**
5 - 500	25/20	30/20	25/20	0.4/0.7	0.5/0.8	0.6/1.0	3.0	4.0	5.0	0.4	0.4	0.6	159	2	**SDL-2**
5 - 750	25/18	30/23	23/17	0.6/1.4	0.8/1.6	1.5/1.8	1.0	3.0	5.0	0.2	0.3	0.5	159	2	**SDL-174** ■
5 - 500	25/20	30/20	25/20	0.4/0.7	0.5/0.8	0.6/1.0	3.0	4.0	5.0	0.4	0.4	0.6	134S	2	**SDZ-2**
10 - 1000	25/20	30/17	25/17	0.5/0.8	0.6/1.0	1.0/1.5	2.0	4.0	7.0	0.4	0.5	0.7	159	2	**SDL-3**
10 - 1000	25/20	30/17	25/17	0.5/0.8	0.6/1.0	1.0/1.5	2.0	4.0	7.0	0.4	0.5	0.7	134S	2	**SDZ-3**
500 -1500	20/15	20/15	18/13	0.6/0.8	0.7/0.8	1.0/1.4	3.0	4.0	7.0	0.3	0.4	0.7	159	2	**SDL-4** ♦
700 - 900	-/-	-/-	23/20	-/-	-/-	0.5/0.8	-/-	-/-	2.0	-/-	-/-	0.5	134S	2	**SDZ-125**♦
1200 -1600	-/-	-/-	25/18	-/-	-/-	1.0/1.5	-/-	-/-	3.0	-/-	-/-	0.3	159	2	**SDL-5**♦
1700 -2500	-/-	-/-	20/16	-/-	-/-	0.8/1.3	-/-	-/-	10	-/-	-/-	0.9	159	2	**SDL-7**♦

Notes: ■ 75 Ohm Model
Power Rating(All Models) = 1 watt, max
♦ LB = 500-700 MHz, MB = 750-1000 MHz, UB = 1000-1500 Mhz
♦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	*GROUND
#1	2	4,6	1,3,5
#2	6	3,4	1,2,5

*GROUND = Ground externally

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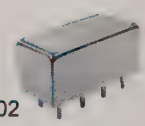
SYNERGY® MICROWAVE CORPORATION

POWER DIVIDERS

0° : 2-WAY

THROUGH HOLE MOUNT (8 Pin-Relay Can)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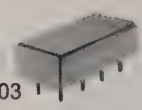
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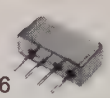
FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.004-60	27/20	30/20	27/20	0.3/0.6	0.3/0.6	0.6/1.0	2.0	3.0	4.0	.15	.25	0.3	102	1	**DSP-2B1**
0.01-100	30/20	27/20	25/20	0.3/0.6	0.3/0.5	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.2	102	1	**DSP-201**
0.1-400	20/15	25/20	25/20	0.2/0.6	0.4/.75	0.6/1.0	2.0	3.0	4.0	.15	0.2	0.3	102	1	**DSP-2A3**
0.25-300	20/15	30/20	20/15	0.4/.75	0.4/.75	0.4/1.0	2.0	3.0	5.0	.15	0.2	0.3	102	1	**DSP-2A2** ■
0.5-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	3.0	0.2	0.2	0.2	103	1	**DSP-202**
1-400	28/20	28/20	25/20	0.4/.65	0.5/0.8	0.7/1.0	3.0	3.0	4.0	0.3	0.3	0.3	102	1	**DSP-209**
1-650	30/20	28/20	25/20	0.4/0.5	0.4/0.8	0.8/1.0	2.0	3.0	5.0	.15	0.2	0.3	102	1	**DSP-222**
5-2000	21/16	22/18	19/14	0.2/0.5	0.5/0.8	0.8/1.1	1.0	3.0	5.0	0.2	0.4	0.6	102	1	**DSP-2A6**
10-850	31/20	32/23	23/15	0.3/0.5	0.4/0.6	0.5/1.0	2.0	5.0	10.0	0.1	0.2	0.5	102	1	**DSP-2D4** ■
10-1000	30/20	28/20	25/20	0.2/0.5	0.6/1.0	0.9/1.2	2.0	4.0	6.0	0.2	0.2	0.4	102	1	**DSP-212**
10-1000	30/25	25/20	25/20	0.6/1.0	0.6/1.2	0.7/1.2	2.0	8.0	10.0	.15	0.2	0.4	102	1	**DSP-2C4**
10-1400	28/18	22/17	24/17	0.3/0.6	0.6/1.0	0.9/1.6	2.0	3.0	4.0	.15	0.2	0.4	102	1	**DSP-2A5**

MINI RELAY HEADER (4-Pin and 8 Pin)

105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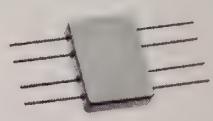
FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.1-450	20/15	30/20	30/20	0.3/0.5	0.4/.75	0.6/1.0	2.0	3.0	4.0	.15	0.2	0.3	107	1	**DSP-4B4**
1-400	30/25	30/25	30/20	.25/0.5	0.5/.75	0.7/1.0	2.0	3.0	4.0	.15	0.2	0.6	106	2	**DSP-3C3**
1-400	28/20	28/20	25/20	0.4/.65	0.5/0.8	0.7/1.0	3.0	3.0	4.0	0.3	0.3	0.3	105	2	**DSP-309**
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.3	105	2	**DSP-302**
1-400	28/20	28/20	25/20	0.4/.65	0.5/0.8	0.7/1.0	3.0	3.0	4.0	0.3	0.3	0.3	107	1	**DSP-409**
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/2.0	2.0	2.0	2.0	0.2	0.2	0.3	107	1	**DSP-402**
2-650	22/18	30/20	22/18	0.3/0.5	0.5/0.8	0.8/1.2	1.0	2.0	4.0	0.3	0.2	0.3	107	1	**DSP-4A4**
5-1500	18/16	20/16	20/14	0.6/0.8	0.6/0.8	0.6/1.1	2.0	3.0	5.0	0.2	0.3	0.4	107	1	**DSP-4A5**

FLAT-PACK



FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1-500	25/20	30/20	30/20	0.4/0.7	0.4/0.7	0.5/1.2	2.0	2.0	3.0	0.2	0.2	0.2	101	3	**DSF-102**
2-1500	25/20	25/20	18/15	0.8/1.3	0.5/1.0	1.0/1.5	2.0	4.0	8.0	0.2	0.3	0.4	101	3	**DSF-103**
5-1000	30/20	30/23	25/20	0.3/0.5	0.5/0.8	0.6/1.0	3.0	2.0	5.0	0.2	0.2	0.2	101	3	**DSF-109**

Notes: ■ 75 Ohm Model
Power Rating(All Models) = 1 watt, max
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#1	1	5,6	All Other
#2	1	2,4	3
#3	8	1,5	All other

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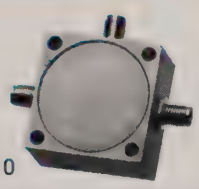
SYNERGY MICROWAVE CORPORATION

POWER DIVIDERS

0° : 2-WAY

COAXIAL CONNECTOR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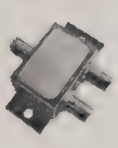
FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-100	30/20	27/20	25/20	0.3/0.6	0.3/0.5	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.2	110	1	DSK-701*
0.25-300	20/15	30/25	25/20	0.4/.75	0.4/.75	0.4/1.0	2.0	3.0	5.0	.15	0.2	0.3	110	1	DSK-7A2B ■
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	3.0	0.2	0.2	0.2	110	1	DSK-702*
1-750	30/20	28/20	25/20	0.2/0.5	0.4/0.8	0.8/1.0	2.0	4.0	4.0	.15	.15	0.3	110	1	DSK-7E4*
2-200	35/30	35/30	35/30	0.2/0.5	0.3/0.5	0.4/0.5	1.0	1.0	1.0	0.2	0.2	0.2	110	1	DSK-7M2*
2-1500	25/20	25/20	25/20	0.8/1.3	0.6/1.2	0.5/1.5	2.0	4.0	6.0	0.2	0.2	0.3	110	1	DSK-703*
5-400	40/30	38/30	35/30	0.2/0.4	0.3/0.5	0.4/0.5	2.0	2.0	2.0	0.2	0.2	0.2	110	1	DSK-718*
5-500	35/30	40/30	35/30	0.3/0.5	0.3/0.5	0.4/.65	2.0	2.0	3.0	0.2	0.2	0.2	110	1	DSK-717*
10-1000	30/20	30/20	25/20	0.2/0.5	0.5/1.0	0.9/1.2	2.0	3.0	5.0	.15	.15	0.3	110	1	DSK-712*
10-1000	30/25	33/25	30/25	0.2/0.5	0.4/0.7	0.6/0.8	2.0	2.0	3.0	0.2	0.2	0.25	110	1	DSK-709*

COAXIAL CONNECTOR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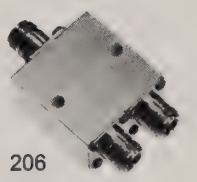
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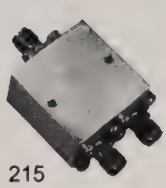
215

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
5-2000	25/20	25/20	23/15	0.6/0.9	0.9/1.4	1.2/1.8	2.0	3.0	5.0	0.2	0.3	0.4	144	2	DSK-726S
700-900	-/-	-/-	30/24	-/-	-/-	0.3/1.0	-	-	5.0	-	-	0.5	164	2	DSK-724S✦
800-2200	-/-	-/-	22/20	-/-	-/-	0.4/0.5	-	-	2.0	-	-	0.4	215	3	DSK-729S✦
1700-2200	-/-	-/-	20/18	-/-	-/-	0.3/0.4	-	-	3.0	-	-	0.3	206	3	DSK-H1N✦

Power Rating (All Models) = 1 Watt, max
* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC
■75 Ohm Model
✦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#1	2	1,3	-
#2	1	2,3	1,5
#3	1	2,3	-

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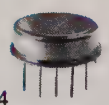
POWER DIVIDERS

0° : 2-WAY

THROUGH HOLE (TO-8 and TO-5)


104

122

126

127

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.01-100	30/20	27/20	25/20	0.3/0.6	0.3/0.5	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.2	122	5	**DSP-601**
1-100	37/30	35/30	35/30	0.2/0.5	0.3/0.5	0.4/0.5	1.0	1.0	1.0	0.1	0.1	0.1	127	4	**DSP-8D1**
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	3.0	0.2	0.2	0.2	122	5	**DSP-602**
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.2	104	3	**DSP-502**
1-500	25/20	30/23	30/20	0.4/0.6	0.4/0.7	0.5/1.0	2.0	2.0	2.0	0.2	0.2	0.2	126	5	**DSP-802**
10-1000	25/20	30/20	25/20	0.2/0.5	0.5/0.8	0.6/1.0	3.0	2.0	4.0	0.2	0.2	0.3	122	5	**DSP-609**

Power Rating (All Models) = 1 Watt, max
* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC
■75 Ohm Model
♦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#3	8	11,5	All Other
#4	3	2,4	1,5
#5	3	2,4	1

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SYNERGY® MICROWAVE CORPORATION

POWER DIVIDERS

0° : 3-WAY

LEADED SURFACE-MOUNT

134S

159

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2-200	30/23	27/20	23/18	0.6/0.8	0.4/0.7	0.7/1.0	3.0	3.0	3.0	0.4	0.3	0.4	159	1	**SDL-110**
5-750	25/18	25/20	23/18	0.6/1.4	0.8/1.6	1.5/1.8	3.0	5.0	7.0	0.3	0.5	0.75	159	1	**SDL-135**
5-750	25/18	25/20	23/18	0.6/1.4	0.8/1.6	1.5/1.8	3.0	5.0	7.0	0.3	0.5	0.75	134S	1	**SDZ-135**
720-800	---/---	---/---	18/15	---/---	---/---	0.4/0.7	--	--	5.0	--	--	0.7	159	1	**SDL-115♦**
850-950	---/---	---/---	17/13	---/---	---/---	1.0/1.4	--	--	5.0	--	--	0.7	159	1	**SDL-137♦**

SURFACE-MOUNT

133M

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
1700-2200	--/--	--/--	23/18	--/--	--/--	0.4/0.8	--	--	5.0	--	--	0.5	133M	2	**SPD-C9♦**

Power Rating (All Models) = 1 Watt, max

* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC

■75 Ohm Model

♦ (UB) - Denotes full bandwidth specification

For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#1	6	1,3,4	2,5
#2	1	2,3,4	
#3	1	2,3	all others

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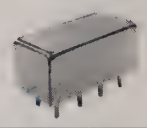
SYNERGY® MICROWAVE CORPORATION

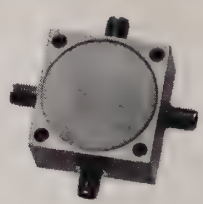
POWER DIVIDERS

0° : 3-WAY



THROUGH HOLE MOUNT (8 Pin-Relay Can)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.01-30	35/30	40/25	30/25	.25/.45	.15/.45	.45/.75	1.0	2.0	4.0	0.2	0.3	0.4	102	2	**DCP-2A1**
1-200	45/27	40/30	40/25	0.6/1.0	0.4/0.7	0.6/1.0	1.0	2.0	4.0	0.2	0.2	0.4	102	2	**DCP-2B2**
1-200	35/23	35/25	35/25	0.6/1.0	0.3/0.7	0.6/1.0	2.0	3.0	4.0	0.2	0.2	0.3	102	2	**DCP-2C2** ■
5-500	25/20	31/15	25/15	0.4/0.8	0.4/1.4	0.8/1.4	6.0	8.0	10	0.2	0.3	0.6	102	3	**DCP-2B3**
10-1000	25/20	23/18	23/18	0.6/1.0	0.8/1.3	1.2/2.0	6.0	8.0	12	0.2	0.4	0.8	102	3	**DCP-2B4**



COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1-200	45/30	48/35	37/30	0.25/0.5	.35/0.6	.35/0.6	1.0	3.0	5.0	0.1	0.2	0.2	113	4	**DCK-7K2***
1-500	30/20	30/20	25/18	0.4/0.75	0.5/0.9	0.8/1.2	2.0	3.0	4.0	0.2	0.3	0.4	113	4	**DCK-7J2***
2-750	30/20	30/20	25/18	0.4/0.75	0.5/1.0	1.0/1.6	3.0	5.0	7.0	0.2	0.3	0.5	113	4	**DCK-7D3***
10-1000	25/20	20/17	20/17	0.5/0.75	0.7/1.0	1.2/2.0	3.0	5.0	7.0	0.3	0.4	0.7	113	4	**DCK-703S**

Power Rating (All Models) = 1 Watt, max

* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC

■75 Ohm Model

♦ (UB) - Denotes full bandwidth specification

For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#2	6	1,2,5	3,4,7,8
#3	1	5,7,8	2,3,4,6
#4	1	2,3,4	-

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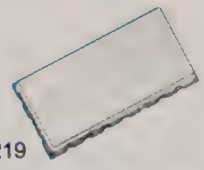
SYNERGY® MICROWAVE CORPORATION

POWER DIVIDERS

0° : 4-WAY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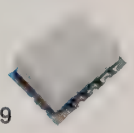
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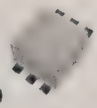
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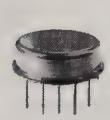
SURFACE-MOUNT MODELS

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1-100	23/20	---/---	25/20	0.7/1.0	---/---	0.5/1.0	3	-	3.0	0.4	-	0.4	159	1	SDL-140
20-400	25/18	---/---	20/17	1.0/1.3	---/---	1.4/1.8	3	-	5.0	0.4	-	0.75	159	1	SDL-120
700-900	---/---	---/---	25/23	---/---	---/---	1.0/1.4	-	-	6.0	---	-	0.8	129	2	SPD-C6♦
1900-2200	---/---	---/---	25/20	---/---	---/---	0.7/1.2	-	-	5.0	---	-	0.5	219	5	DSS-1900♦
2100-2400	---/---	---/---	23/20	---/---	---/---	1.0/1.2	-	-	5.0	---	-	0.5	219	5	DSS-2100♦

THROUGH HOLE MOUNT (8 Pin-Relay Header)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.01-40	35/20	32/25	25/20	0.4/0.8	0.3/0.5	0.5/1.0	3	3	4	0.2	.15	0.2	102	3	DSP-206
0.1-200	33/20	30/20	27/20	0.4/0.6	0.5/.75	0.7/1.0	4	6	8	0.15	0.2	.25	102	3	DSP-2D2
0.25-250	33/20	30/20	27/20	0.4/0.7	0.5/.75	0.7/1.2	4	6	8	0.15	0.2	.25	102	3	DSP-2F2
1-200	30/20	25/20	25/20	0.4/0.7	0.5/0.9	0.7/1.2	4	6	10	0.15	0.2	0.3	102	3	DSP-2E2 ■
1-250	33/20	30/20	27/20	0.4/0.7	0.5/.75	0.7/1.2	3	3	4	0.25	0.2	0.3	102	3	DSP-204
1-500	25/20	27/20	25/20	0.6/1.2	0.8/1.5	1.4/2.2	4	4	6	0.5	0.4	0.5	102	3	DSP-207
10-1000	25/20	24/20	24/20	1.2/1.7	1.2/1.9	1.6/2.3	5	7	10	0.2	0.5	0.8	102	3	DSP-2E4 ■
1900-2130	---/---	---/---	25/20	---/---	---/---	1.8/2.4	-	-	6	-	-	0.7	102	3	DSP-247♦

THROUGH HOLE MOUNT (TO-8)



FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.01-40	35/20	32/25	25/20	0.4/0.8	0.3/0.5	0.5/1.0	3	3	4	0.2	0.15	0.2	123	4	DSP-506
1-250	33/20	30/20	27/20	0.4/0.7	0.5/.75	0.7/1.2	3	3	4	0.25	0.2	0.3	123	4	DSP-504
1-500	25/20	27/20	25/20	0.6/1.2	0.8/1.5	1.4/2.2	4	4	6	0.5	0.4	0.5	123	4	DSP-507

Power Rating (All Models) = 1 Watt, max

■ 75 Ohm Model

♦ (UB) - Denotes full bandwidth specification

For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#1	5	1,3,4,6	2
#2	2	1,3,4,6	All other
#3	4	1,2,7,8	All other
#4	2	4,6,10,12	All Other
#5	1	2,3,4,5	

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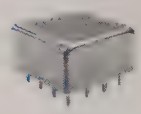
POWER DIVIDERS

0° : 4-WAY

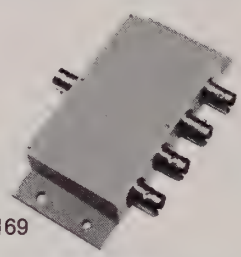


THROUGH HOLE MOUNT (16 Pin-Header)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10-800	30/20	33/20	25/18	0.4/0.7	0.7/0.9	1.3/1.6	5.0	7.0	10	0.2	0.4	0.8	124	1	**DSP-9E4** ■
10-1000	25/20	21/15	18/15	0.5/0.8	0.8/1.8	1.5/2.5	4.0	6.0	10	0.2	0.5	0.7	124	1	**DSP-9D4**
10-1000	25/20	25/18	20/15	0.8/1.5	1.0/2.0	1.5/2.5	4.0	6.0	10	0.4	0.5	0.7	124	1	**DSP-908**

COAXIAL CONNECTOR

111



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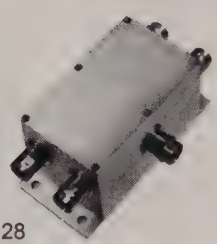

128

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.01-40	35/20	32/25	25/20	0.4/0.8	0.3/0.5	0.5/1.0	3.0	3.0	4.0	0.2	0.15	0.2	111	2	**DSK-706***
1-200	30/20	25/20	25/20	0.4/0.7	0.5/0.9	0.7/1.2	4.0	6.0	10.0	0.15	0.2	0.3	169	2	**DSK-7E2B** ■
1-250	33/20	30/20	27/20	0.4/0.7	0.5/.75	0.7/1.2	3.0	3.0	4.0	.25	0.2	0.3	111	2	**DSK-704***
1-500	25/20	25/20	23/20	0.8/1.2	0.6/1.2	1.0/1.5	4.0	3.0	5.0	0.4	0.3	0.4	111	2	**DSK-707***
1-1000	25/15	25/20	20/15	0.6/1.5	1.0/2.0	1.5/2.5	5.0	6.0	8.0	0.5	0.5	0.5	111	2	**DSK-708***
10-500	33/25	30/25	28/25	0.5/0.7	0.7/.85	.85/1.0	2.0	4.0	6.0	0.2	0.2	0.4	128	2	**DSK-711S**
20-1000	30/25	30/23	25/20	0.6/1.2	0.8/1.3	1.0/1.5	3.0	4.0	8.0	0.3	0.4	0.5	128	2	**DSK-713S**
30-1000	30/25	30/25	30/25	0.8/1.0	0.8/1.0	0.8/1.1	2.0	3.5	8.0	0.3	0.3	0.5	128	2	**DSK-705S**

Power Rating (All Models) = 1 Watt, max
* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC
■ 75 Ohm Model
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND
#1	2	5,8,9,12	All other
#2	1	2,3,4,5	All other

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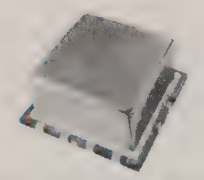
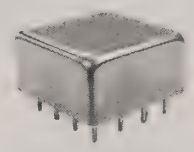
POWER DIVIDERS

0° : 5-WAY



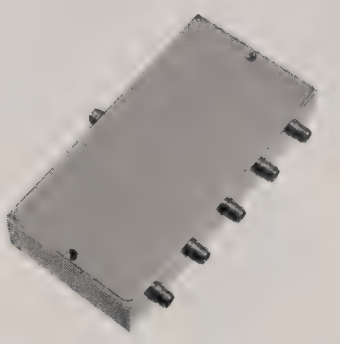
SURFACE MOUNT

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.05-30	28/20	30/25	25/20	0.4/0.8	0.3/0.7	0.6/1.0	4.0	4.0	4.0	0.3	0.3	0.3	124S	1	**DES-901**
1-300	25/20	23/18	20/17	0.2/0.5	0.6/1.0	1.5/2.0	2.0	4.0	8.0	0.2	0.3	0.6	124S	1	**DES-9G2**



THROUGH HOLE MOUNT(16-Pin)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.05-30	28/20	30/25	25/20	0.4/0.8	0.3/0.7	0.6/1.0	4.0	4.0	4.0	0.3	0.3	0.3	124	2	**DEP-901**
1-300	25/20	23/18	20/17	0.2/0.5	0.6/1.0	1.5/2.0	2.0	4.0	8.0	0.2	0.3	0.6	124	2	**DEP-9G2**



COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
0.05-30	25/20	30/25	25/20	0.5/0.9	0.3/0.7	0.6/1.0	4.0	4.0	4.0	0.3	0.3	0.3	157	3	**DEK-701***
1-300	25/20	23/18	20/17	0.2/0.5	0.6/1.0	1.5/2.0	2.0	4.0	8.0	0.2	0.3	0.6	157	3	**DEK-7G2***

Power Rating (All Models) = 1 Watt, max
* Select female connector suffix: "B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND	NO CONN.
#1	1	4,8,12,15,16	2,5,13,14	3,9
#2	1	4,8,12,15,16	2,5,7,11,13,14	3,6,9,10
#3	1	2,3,4,5,6	-	-

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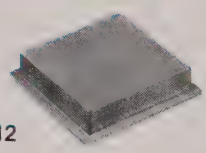
POWER DIVIDERS

0° :6-WAY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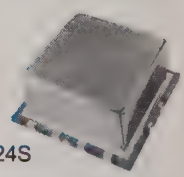
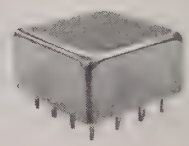

124S

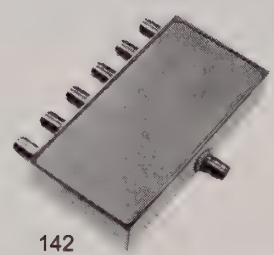
SURFACE MOUNT

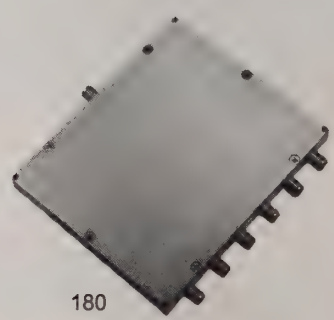
FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1-100	30/25	28/25	25/23	0.5/0.8	0.7/1.0	0.7/1.2	2.0	4.0	8.0	0.2	0.3	0.5	124S	1	**DFS-9B1**
1-175	30/24	26/18	26/18	0.5/0.8	0.7/1.0	1.0/1.5	4.0	6.0	12	0.2	0.4	0.8	124S	1	**DFS-9H2**
5-200	30/25	28/23	25/20	0.4/0.7	0.5/0.8	0.8/1.2	2.0	3.0	4.0	0.2	0.3	0.4	124S	1	**DFS-902**
5-500	30/20	25/20	25/20	0.5/0.8	0.7/0.8	0.8/1.4	3.0	4.0	6.0	0.3	0.5	0.7	124S	1	**DFS-903**
1600-2200	--/--	--/--	25/20	--/--	--/--	0.6/0.8	--	--	6.0	--	--	0.5	212	3	**DFS-1600†**



THROUGH HOLE MOUNT(16 -Pin)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
1-100	30/25	28/25	25/23	0.5/0.8	0.7/1.0	0.7/1.2	2.0	4.0	8.0	0.2	0.3	0.5	124	2	**DFP-9B1**
1-175	30/24	26/18	26/18	0.5/0.8	0.7/1.0	1.0/1.5	4.0	6.0	12	0.2	0.4	0.8	124	2	**DFP-9H2**
5-200	30/25	28/23	25/20	0.4/0.7	0.5/0.8	0.8/1.2	2.0	3.0	4.0	0.2	0.3	0.4	124	2	**DFP-902**
5-500	30/20	25/20	25/20	0.5/0.8	0.7/0.8	0.8/1.4	3.0	4.0	6.0	0.3	0.5	0.7	124	2	**DFP-903**


142


180

COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
5-200	30/25	28/23	25/20	0.4/0.7	0.5/0.8	0.8/1.2	2.0	3.0	4.0	0.2	0.3	0.4	142	3	**DFK-702S**
5-500	26/23	30/23	25/20	0.4/0.7	0.6/0.9	1.2/1.6	2.0	4.0	7.0	0.2	0.3	0.4	142	3	**DFK-703S**
800-1000	---/---	---/---	30/20	---/---	---/---	1.4/1.8	-	-	8.0	-	-	0.8	180	3	**DFK-764S†**

Power Rating (All Models) = 1 Watt, max
† (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND	NOT USED
#1	1	3,4,8,12,15,16	2, 5,9,13,14	
#2	1	3,4,8,12,15,16	2,5,7,11,13,14	6,9,10
#3	1	2,3,4,5,6,7	All others	-

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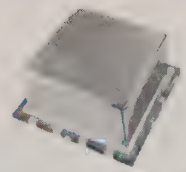
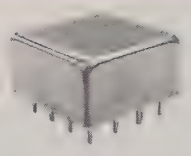
POWER DIVIDERS

0° : 8-WAY



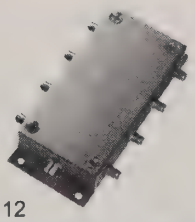
SURFACE MOUNT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-10	40/20	40/25	28/23	0.3/0.7	0.5/1.0	0.6/1.1	1.0	2.5	4.0	0.1	0.2	0.3	124S	1	DSS-9C1
0.01-30	33/20	30/25	35/23	0.3/0.6	0.7/0.9	0.8/1.0	1.5	3.0	4.0	0.3	0.2	0.3	124S	1	DSS-914
0.5-175	30/25	30/20	25/18	0.8/1.2	0.8/1.2	1.0/1.6	1.0	2.5	5.0	0.2	0.3	0.5	124S	1	DSS-9L2
1-200	30/25	30/20	25/20	0.8/1.2	0.8/1.2	1.0/1.5	1.5	3.0	6.0	0.2	0.3	0.4	124S	1	DSS-915
1-500	25/20	30/20	30/20	1.0/1.8	1.8/2.0	1.8/2.7	3.0	6.0	12.0	0.2	0.3	0.5	124S	1	DSS-916



THROUGH HOLE MOUNT(16 - Pin)

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-10	40/20	40/25	28/23	0.3/0.7	0.5/1.0	0.6/1.1	1.0	2.5	4.0	0.1	0.2	0.3	124	2	DSP-9C1
0.01-30	33/20	30/25	35/23	0.3/0.6	0.7/0.9	0.8/1.0	1.5	3.0	4.0	0.3	0.2	0.3	124	3	DSP-914
0.5-175	30/25	30/20	25/18	0.8/1.2	0.8/1.2	1.0/1.6	1.0	2.5	5.0	0.2	0.3	0.5	124	2	DSP-9L2
1-200	30/25	30/20	25/20	0.8/1.2	0.8/1.2	1.0/1.5	1.5	3.0	6.0	0.2	0.3	0.4	124	3	DSP-915
1-500	25/20	30/20	30/20	1.0/1.8	1.8/2.0	1.8/2.7	3.0	6.0	12.0	0.2	0.3	0.5	124	2	DSP-916



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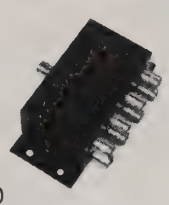

170

COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-30	33/20	30/25	35/23	0.3/0.6	0.7/0.9	0.8/1.0	1.5	3.0	4.0	0.3	0.2	0.3	112	4	DSK-714*
1-200	30/25	30/20	25/20	0.8/1.2	0.8/1.2	1.0/1.5	1.5	3.0	6.0	0.2	0.3	0.3	112	4	DSK-715*
1-500	25/20	30/20	30/20	1.0/1.8	1.8/2.0	1.8/2.7	3.0	6.0	10.0	0.2	0.3	0.5	112	4	DSK-716*
5-200	30/20	25/20	25/20	0.4/0.7	0.5/0.9	0.7/1.2	4.0	6.0	10.0	0.15	0.2	0.3	170	2	DSK-773B■
30-1000	23/20	25/20	23/20	0.8/1.2	1.6/2.1	2.5/2.8	3.0	8.0	12.0	0.3	0.4	0.7	112	4	DSK-810S

Power Rating (All Models) = 1 Watt, max

* Select female connector suffix:
"B" = BNC, "S" = SMA, "N" = Type N, "T" = TNC

■ 75 Ohm Model

For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CASE GROUND	NOT USED
# 1	2	1,4,5,8,9,12,13,16	3, 14,15	-
# 2	2	1,4,5,8,9,12,13,16	3,6,7,14,15	10,11
# 3	2	1,4,5,8,9,12,13,16	All Other	-
# 4	1	2,3,4,5,6,7,8,9	-	-

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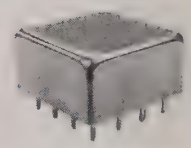
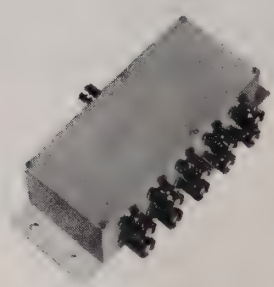
POWER DIVIDERS

0° : 10-WAY



THROUGH HOLE MOUNT (16 -Pin)

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
1-150	36/23	27/23	23/18	0.3/0.6	0.4/0.8	1.0/1.3	1	4	10	0.1	0.2	0.3	124	1	**DXP-9A2**



COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
5-200	25/20	32/23	25/18	0.8/1.3	0.9/1.2	1.2/1.6	4.0	6.0	8.0	0.5	0.6	0.8	171	2	**DXK-772B■**
5-200	25/20	32/25	25/20	0.7/1.2	0.9/1.1	1.2/1.5	4.0	6.0	8.0	0.5	0.6	0.8	171	2	**DXK-702B**

Power Rating (All Models) = 1 Watt, max

■ 75 Ohm Model

For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUTS	CASE GROUND
#1	1	2,3,4,8,9,12,13,14,15,16	5,6,7,10,11
#2	1	2,3,4,5,6,7,8,9,10,11	-

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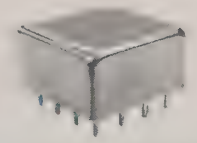
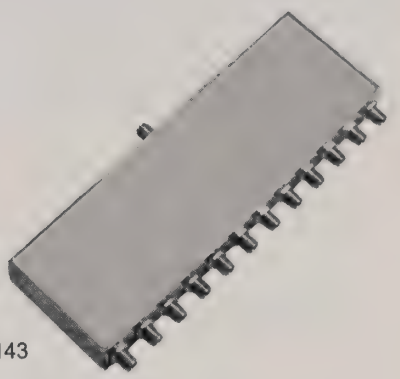
POWER DIVIDERS
0° : 12-WAY



THROUGH HOLE MOUNT(16 - Pin)

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
2-100	25/20	33/20	34/20	0.4/0.8	0.4/0.8	0.6/1.0	2.0	2.0	3.0	0.4	0.4	0.6	124	1	DLP-901

172



143

COAXIAL CONNECTOR

FREQUENCY RANGE (MHz)	ISOLATION (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	PHASE UNBALANCE (Degrees) LB MAX	MB MAX	UB MAX	AMPLITUDE UNBALANCE (dB) LB MAX	MB MAX	UB MAX	PACKAGE	PIN-OUT (See Below)	MODEL
3-250	25/20	32/25	30/23	1.0/1.3	0.9/1.2	1.6/2.0	3.0	6.0	10	0.3	0.4	0.8	143	2	DLK-712S
5-200	25/20	32/25	25/20	0.7/1.2	0.9/1.1	1.2/1.5	4.0	6.0	8.0	0.5	0.6	0.8	172	2	DLK-702B
5-200	25/20	32/23	25/18	0.8/1.3	0.9/1.2	1.2/1.6	4.0	6.0	8.0	0.5	0.6	0.8	172	2	DLK-772B ■
850-1000	---/---	---/---	20/15	---/---	---/---	3.0/4.0	-	-	8.0	-	-	2.0	143	2	DLK-7L4S♦

Power Rating (All Models) = 1 Watt, max
■75 Ohm Model
♦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUTS	CASE GROUND
#1	6	1,2,3,4,5,8,9,12,13,14,15,16	7,10,11
#2	1	2,3,4,5,6,7,8,9,10,11,12,13	-

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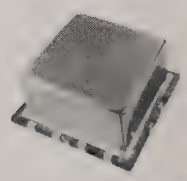
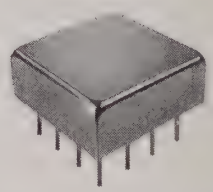
PHASE COMPARATORS



SURFACE-MOUNT MODELS

FREQUENCY RANGE (MHz) LO/RF	IMPEDANCE (Ohm) LO/RF	IMPEDANCE (Ohm) OUTPUT	LO POWER LEVEL (dBm)	RF POWER LEVEL (dBm)	PHASE ERROR MAX	PHASE RANGE NOM.	DC OUTPUT (mV p-p) TYP	DC OFFSET (mV) TYP/MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10-20	50	500	+10	0	+/-2°	360°	300	0.3/1.0	124S	1	**PCS-901**
20-40	50	500	+10	0	+/-2°	360°	300	0.4/1.0	124S	1	**PCS-902**
55-90	50	500	+10	0	+/-2°	360°	300	0.5/2.0	124S	1	**PCS-904**
80-160	50	500	+10	0	+/-3°	360°	300	1.0/2.0	124S	1	**PCS-908**
100-200	50	500	+10	0	+/-3°	360°	300	1.0/3.0	124S	1	**PCS-910**
160-320	50	500	+10	0	+/-4°	360°	300	1.0/3.0	124S	1	**PCS-916**
225-400	50	500	+10	0	+/-4°	360°	300	1.0/4.0	124S	1	**PCS-922**
300-500	50	500	+10	0	+/-4°	360°	300	2.0/5.0	124S	1	**PCS-930**
400-600	50	500	+10	0	+/-5°	360°	300	2.0/6.0	124S	1	**PCS-940**
700-900	50	500	+10	0	+/-5°	360°	300	2.0/8.0	124S	1	**PCS-970**
800-1000	50	500	+10	0	+/-5°	360°	300	3.0/10.0	124S	1	**PCS-980**



THROUGH HOLE MODELS

FREQUENCY RANGE (MHz) LO/RF	IMPEDANCE (Ohm) LO/RF	IMPEDANCE (Ohm) OUTPUT	LO POWER LEVEL (dBm)	RF POWER LEVEL (dBm)	PHASE ERROR MAX	PHASE RANGE NOM.	DC OUTPUT (mV p-p) TYP	DC OFFSET (mV) TYP/MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10-20	50	500	+10	0	+/-2°	360°	300	0.3/1.0	136	2	**PCP-901**
20-40	50	500	+10	0	+/-2°	360°	300	0.4/1.0	136	2	**PCP-902**
55-90	50	500	+10	0	+/-2°	360°	300	0.5/2.0	136	2	**PCP-904**
80-160	50	500	+10	0	+/-3°	360°	300	1.0/2.0	136	2	**PCP-908**
100-200	50	500	+10	0	+/-3°	360°	300	1.0/3.0	136	2	**PCP-910**
160-320	50	500	+10	0	+/-4°	360°	300	1.0/3.0	136	2	**PCP-916**
225-400	50	500	+10	0	+/-4°	360°	300	1.0/4.0	136	2	**PCP-922**
300-500	50	500	+10	0	+/-4°	360°	300	2.0/5.0	136	2	**PCP-930**
400-600	50	500	+10	0	+/-5°	360°	300	2.0/6.0	136	2	**PCP-940**
700-900	50	500	+10	0	+/-5°	360°	300	2.0/8.0	136	2	**PCP-970**
800-1000	50	500	+10	0	+/-5°	360°	300	3.0/10.0	136	2	**PCP-980**

NOTE:
1. Output polarity is negative on all models.
2. Maximum RF input power, 100 mW. Peak IF current, 40mA.

PIN-OUT TABLE

	LO	RF	SINE	COSINE	CASE GND
#1	16	1	13	4	All Other
# 2	1	7	8	3	All Other

For pin location and package outline drawings, see back pages.

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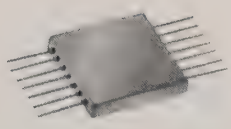
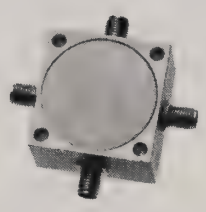
PHASE COMPARATORS



FLAT PACK MODELS

FREQUENCY RANGE (MHz) LO/RF	IMPEDANCE (Ohm) LO/RF	IMPEDANCE (Ohm) OUTPUT	LO POWER LEVEL (dBm)	RF POWER LEVEL (dBm)	PHASE ERROR MAX	PHASE RANGE NOM.	DC OUTPUT (mV p-p) TYP	DC OFFSET (mV) TYP/MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10-20	50	500	+10	0	+/-2°	360°	300	0.3/1.0	115	1	PCF-101
20-40	50	500	+10	0	+/-2°	360°	300	0.4/1.0	115	1	PCF-102
55-90	50	500	+10	0	+/-2°	360°	300	0.5/2.0	115	1	PCF-104
80-160	50	500	+10	0	+/-3°	360°	300	1.0/2.0	115	1	PCF-108
100-200	50	500	+10	0	+/-3°	360°	300	1.0/3.0	115	1	PCF-110
160-320	50	500	+10	0	+/-4°	360°	300	1.0/3.0	115	1	PCF-116
225-400	50	500	+10	0	+/-4°	360°	300	1.0/4.0	115	1	PCF-122
300-500	50	500	+10	0	+/-4°	360°	300	2.0/5.0	115	1	PCF-130
400-600	50	500	+10	0	+/-5°	360°	300	2.0/6.0	115	1	PCF-140
700-900	50	500	+10	0	+/-5°	360°	300	2.0/8.0	115	1	PCF-170
800-1000	50	500	+10	0	+/-5°	360°	300	3.0/10.0	115	1	PCF-180



COAXIAL (SMA-F) CONNECTOR MODELS

FREQUENCY RANGE (MHz) LO/RF	IMPEDANCE (Ohm) LO/RF	IMPEDANCE (Ohm) OUTPUT	LO POWER LEVEL (dBm)	RF POWER LEVEL (dBm)	PHASE ERROR MAX	PHASE RANGE NOM.	DC OUTPUT (mV p-p) TYP	DC OFFSET (mV) TYP/MAX	PACKAGE	PIN-OUT (See Below)	MODEL
10-20	50	500	+10	0	+/-2°	360°	300	0.3/1.0	113	2	PCK-701S
20-40	50	500	+10	0	+/-2°	360°	300	0.4/1.0	113	2	PCK-702S
55-90	50	500	+10	0	+/-2°	360°	300	0.5/2.0	113	2	PCK-704S
80-160	50	500	+10	0	+/-3°	360°	300	1.0/3.0	113	2	PCK-708S
100-200	50	500	+10	0	+/-3°	360°	300	1.0/3.0	113	2	PCK-710S
160-320	50	500	+10	0	+/-4°	360°	300	1.0/4.0	113	2	PCK-716S
225-400	50	500	+10	0	+/-4°	360°	300	2.0/5.0	113	2	PCK-722S
300-500	50	500	+10	0	+/-4°	360°	300	2.0/6.0	113	2	PCK-730S
400-600	50	500	+10	0	+/-5°	360°	300	2.0/6.0	113	2	PCK-740S
700-900	50	500	+10	0	+/-5°	360°	300	2.0/8.0	113	2	PCK-770S
800-1000	50	500	+10	0	+/-5°	360°	300	3.0/10.0	113	2	PCK-780S

NOTE:
1. Output polarity is negative on all models.
2. Maximum RF input power, 200 mW. Peak IF current, 40mA.

PIN-OUT TABLE

	LO	RF	SINE	COSINE	CASE GND
# 1	14	1	10	3	All Other
# 2	3	1	2	4	All Other

For pin location and package outline drawings, see back pages.

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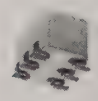
PHASE DETECTORS

SURFACE-MOUNT



FREQUENCY RANGE (MHz)		IMPEDANCE (Ohm)		POWER LEVEL	ISOLATION (dB) LO/RF	DC OUTPUT (mV)	DC OFFSET (mV)	PACKAGE	PIN-OUT (See Below)	MODEL
LO/RF	OUTPUT	LO/RF	OUTPUT	(dBm)	MIN	TYP/MIN	TYP/MAX			
1-100	DC-50	50	500	+7	40	1000/750	0.2/1.0	134S	1	**PDZ-K1**
10-200	DC-50	50	500	+7	40	1000/750	0.3/1.0	134S	1	**PDZ-K2**

THROUGH HOLE MOUNT

MINI 8 PIN - RELAY CAN

FREQUENCY RANGE (MHz)		IMPEDANCE (Ohm)		POWER LEVEL	ISOLATION (dB) LO/RF	DC OUTPUT (mV)	DC OFFSET (mV)	PACKAGE	PIN-OUT (See Below)	MODEL
LO/RF	OUTPUT	LO/RF	OUTPUT	(dBm)	MIN	TYP/MIN	TYP/MAX			
1-100	DC-50	50	500	+7	40	1000/750	0.2/1.0	108	2	**PDP-403**
10-200	DC-50	50	500	+7	40	1000/750	0.3/1.0	108	2	**PDP-402**
50-400	DC-50	50	500	+7	35	600/500	0.5/1.0	108	2	**PDP-413**

8 PIN - RELAY CAN

FREQUENCY RANGE (MHz)		IMPEDANCE (Ohm)		POWER LEVEL	ISOLATION (dB) LO/RF	DC OUTPUT (mV)	DC OFFSET (mV)	PACKAGE	PIN-OUT (See Below)	MODEL
LO/RF	OUTPUT	LO/RF	OUTPUT	(dBm)	MIN	TYP/MIN	TYP/MAX			
1-100	DC-50	50	500	+7	40	1000/750	0.2/1.0	102	2	**PDP-201**
5-150	DC-50	50	500	+7	40	1000/750	0.3/1.0	102	2	**PDP-202**

NOTE:
1. Output polarity is negative on all models.
2. Maximum RF input power, 100 mW. Peak IF current, 40mA.

PIN-OUT TABLE

	LO	RF	DC OUTPUT	GROUND	CASE GND
# 1	1	4	5	2,3,6	—
# 2	8	1	*3,4	2,5,6,7	2

*Pins must be connected together externally.
For pin location and package outline drawings, see back pages.

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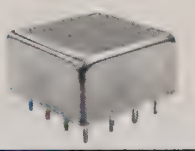
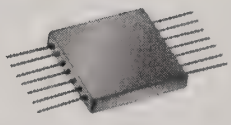
PHASE SHIFTERS



THROUGH HOLE MODELS

INPUT FREQUENCY (MHz)	INPUT POWER (dBm) MAX	INSERTION LOSS (dB) TYP	INSERTION LOSS (dB) MAX	PHASE SHIFT RANGE (Degrees) MIN	CONTROL VOLTAGE (Vdc)	CONTROL BANDWIDTH (KHz) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
5.7 - 6.3	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-900**
10 - 20	-10	2.0	3.5	0 to 180	0 to +24	DC - 50	1.7:1	124	1	**PP-921**
19 - 21	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-909**
20 - 40	-10	2.5	4.0	0 to 180	0 to +15	DC - 50	2.0:1	124	1	**PP-924**
24 - 48	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-925**
28.5 - 31.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-901**
35 - 60	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-926**
38 - 42	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-920**
40 - 80	-10	1.5	2.0	0 to 180	0 to +24	DC - 50	2.0:1	124	1	**PP-927**
47.5 - 52.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-908**
57 - 63	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-902**
66.5 - 73.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-904**
80 - 160	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-922**
100 - 200	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-923**
106.5 - 119.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-905**
133 - 147	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-906**
152 - 168	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124	1	**PP-907**
870 - 900	-10	1.5	2.0	0 to 50	0 to +10	DC - 50	1.7:1	124	1	**PP-919**



FLAT PACK MODELS

INPUT FREQUENCY (MHz)	INPUT POWER (dBm) MAX	INSERTION LOSS (dB) TYP	INSERTION LOSS (dB) MAX	PHASE SHIFT RANGE (Degrees) MIN	CONTROL VOLTAGE (Vdc)	CONTROL BANDWIDTH (KHz) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
19 - 21	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-109**
28.5 - 31.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-101**
38 - 42	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-120**
57 - 63	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-102**
66.5 - 73.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-104**
80 - 160	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-122**
100 - 200	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-123**
106.5 - 119.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-105**
133 - 147	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-106**
152 - 168	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	115	2	**PF-107**

Note: Nominal impedance is 50 Ohms.

PIN-OUT TABLE

	INPUT	OUTPUT	CONTROL	CASE GROUND
#1	1	13	4	All Other
#2	14	7	1,8	All Other

For pin location and package outline drawings, see back pages.

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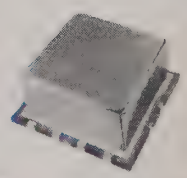
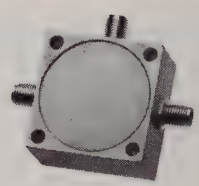
PHASE SHIFTERS



SURFACE-MOUNT MODELS

INPUT FREQUENCY (MHz)	INPUT POWER (dBm) MAX	INSERTION LOSS (dB) TYP	INSERTION LOSS (dB) MAX	PHASE SHIFT RANGE (Degrees) MIN	CONTROL VOLTAGE (Vdc)	CONTROL BANDWIDTH (KHz) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
19 - 21	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-909**
28.5 - 31.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-901**
38 - 42	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-920**
57 - 63	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-902**
66.5 - 73.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-904**
80 - 160	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-922**
100 - 200	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-923**
106.5 - 119.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-905**
133 - 147	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-906**
152 - 168	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	124S	1	**PS-907**



COAXIAL CONNECTOR MODELS

INPUT FREQUENCY (MHz)	INPUT POWER (dBm) MAX	INSERTION LOSS (dB) TYP	INSERTION LOSS (dB) MAX	PHASE SHIFT RANGE (Degrees) MIN	CONTROL VOLTAGE (Vdc)	CONTROL BANDWIDTH (KHz) MIN	VSWR MAX	PACKAGE	PIN-OUT (See Below)	MODEL
2.375 - 2.675	-10	1.2	2.0	0 to 180	0 to +30	DC - 50	1.5:1	110	2	**PK-710***
4.75 - 5.25	-10	1.2	2.0	0 to 180	0 to +30	DC - 50	1.5:1	110	2	**PK-711***
19 - 21	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-709***
28.5 - 31.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-701***
35 - 70	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-712***
38 - 42	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-720***
57 - 63	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-702***
66.5 - 73.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-704***
80 - 160	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-722***
100 - 200	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-723***
106.5 - 119.5	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-705***
133 - 147	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-706***
152 - 168	-10	1.2	1.5	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-707***
190 - 210	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.7:1	110	2	**PK-714***
500	-10	1.5	2.0	0 to 180	0 to +30	DC - 50	1.8:1	110	2	**PK-715***

*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC.
Note: Nominal impedance is 50 Ohms.

PIN-OUT TABLE

	INPUT	OUTPUT	CONTROL	CASE GND
#1	1	13	4	All Other
#2	1	3	2	

For pin location and package outline drawings, see back pages.

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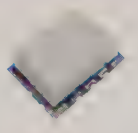
90° HYBRIDS

LEADLESS SURFACE MOUNT



FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
0.5 - 1	0.3/0.6	0.4/0.75	1.0/3.0	25/17	1.1:1	129	1	SMQ-C31
7- 14	0.3/0.6	0.4/0.75	1.0/3.0	25/17	1.1:1	129	1	SMQ-CB1
7 - 21	0.3/0.6	0.6/1.0	1.0/3.0	23/20	1.2:1	129	1	SMQ-C08
10 - 20	0.3/0.6	0.4/0.75	1.0/3.0	25/17	1.1:1	129	1	SMQ-C06
10.2-11.2	0.1/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C51
14 - 42	0.3/0.6	0.4/0.75	1.0/3.0	25/17	1.1:1	129	1	SMQ-C09
19 - 21	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C57
20 - 40	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	129	1	SMQ-C01
20.3 - 22.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C52
28.5 - 31.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C53
38 - 42	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C58
40 - 80	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	129	1	SMQ-C02
50 - 100	0.3/0.6	0.4/0.75	1.0/3.0	25/17	1.1:1	129	1	SMQ-C10
52 - 88	0.3/0.6	0.2/0.6	1.0/2.5	25/17	1.1:1	129	1	SMQ-C20
55 - 90	0.3/0.7	0.6/1.2	1.0/3.0	30/17	1.2:1	129	1	SMQ-C23
57 - 63	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C54
60 - 80	0.2/0.6	0.2/0.6	1.0/2.5	30/17	1.1:1	129	1	SMQ-C22
66.5 - 73.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C56
76 - 84	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	129	2	SMQ-C61
80 - 160	0.4/0.75	0.5/1.0	1.0/3.0	25/17	1.3:1	129	1	SMQ-C03
95 - 105	0.2/0.3	0.2/0.6	1.0/3.0	25/17	1.1:1	129	2	SMQ-C62
100 - 200	0.4/0.75	0.5/1.0	1.0/3.0	25/18	1.1:1	129	1	SMQ-C04
100 - 230	0.4/0.7	0.8/1.2	2.0/4.0	23/17	1.3:1	129	1	SMQ-C11
104 - 176	0.3/0.6	0.2/0.6	1.0/2.5	25/17	1.3:1	129	1	SMQ-C21
114 - 126	0.2/0.3	0.5/0.8	1.0/3.0	25/17	1.1:1	129	2	SMQ-C66
133 - 147	0.2/0.3	0.5/0.8	1.0/3.0	25/17	1.1:1	129	2	SMQ-C63
150 - 300	0.4/0.75	0.5/1.0	1.0/3.0	25/17	1.3:1	129	1	SMQ-C05
190 - 210	0.2/0.4	0.5/0.8	1.0/3.0	25/17	1.2:1	129	2	SMQ-C64
200 - 400	0.4/0.75	1.0/1.5	2.0/4.0	25/17	1.3:1	129	1	SMQ-C07
285 - 315	0.2/0.4	0.5/0.8	2.0/3.0	25/17	1.2:1	129	2	SMQ-C65
350 - 450	0.5/0.8	0.6/1.0	2.0/4.0	25/17	1.3:1	129	1	SMQ-C13
428 - 473	0.2/0.4	0.5/0.9	1.0/3.0	25/17	1.3:1	129	2	SMQ-C67
475 - 525	0.2/0.4	0.5/0.9	1.0/3.0	25/17	1.3:1	129	2	SMQ-C74
570 - 630	0.2/0.3	0.5/0.7	1.0/3.0	25/17	1.2:1	129	2	SMQ-C68

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**	NO CONN.
#1	5	1	2	6	7,8,9,10	3,4
#2	1	6	3	4	7,8,9,10	2,5

*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally

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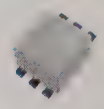
90° HYBRIDS

LEADED SURFACE-MOUNT



FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	MODEL
5.5-16.5	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.2:1	159	**SLQ-301**
10.2-11.2	0.1/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-51**
19 - 21	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-57**
20 - 40	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	159	**SLQ-K01**
20 - 60	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.2:1	159	**SLQ-302**
20.3 - 22.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-52**
25 - 50	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.2:1	159	**SLQ-KF1**
28.5 - 31.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-53**
30 - 60	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.2:1	159	**SLQ-KH1**
30 - 90	0.3/0.6	0.8/1.2	1.0/3.0	23/18	1.2:1	159	**SLQ-303**
38 - 42	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-58**
40 - 80	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.2:1	159	**SLQ-K02**
40 - 120	0.3/0.6	0.8/1.2	2.0/4.0	23/17	1.3:1	159	**SLQ-305**
50 - 100	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.2:1	159	**SLQ-K20**
57 - 63	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-54**
60 - 120	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.2:1	159	**SLQ-KA2**
66.5 - 73.5	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-56**
70 - 140	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.2:1	159	**SLQ-KA3**
76 - 84	0.2/0.3	0.5/0.8	1.0/3.0	25/20	1.1:1	159	**SLQ-61**
80 - 160	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.2:1	159	**SLQ-KA4**
90 - 270	0.4/0.7	0.8/1.3	2.0/4.0	23/17	1.3:1	159	**SLQ-304**
95 - 105	0.2/0.3	0.5/0.8	1.0/3.0	25/17	1.1:1	159	**SLQ-62**
100 - 200	0.4/0.75	0.5/1.0	1.0/3.0	25/18	1.2:1	159	**SLQ-K04**
115 - 345	0.5/0.8	0.8/1.4	2.0/4.0	23/17	1.3:1	159	**SLQ-310**
114 - 126	0.2/0.3	0.5/0.8	1.0/3.0	25/17	1.1:1	159	**SLQ-66**
133 - 147	0.2/0.3	0.5/0.8	1.0/3.0	25/17	1.1:1	159	**SLQ-63**
150 - 300	0.4/0.75	0.5/1.0	1.0/3.0	25/17	1.3:1	159	**SLQ-K05**
190 - 210	0.2/0.4	0.5/0.8	1.0/3.0	25/17	1.2:1	159	**SLQ-64**
225 - 400	0.4/0.75	0.6/1.2	2.0/4.0	25/17	1.3:1	159	**SLQ-K07**
240-720	0.7/1.0	1.2/1.8	3.0/5.0	23/15	1.35:1	159	**SLQ-330**
250 - 500	0.5/0.8	0.6/1.2	2.0/4.0	25/15	1.3:1	159	**SLQ-K08**
285 - 315	0.2/0.4	0.5/0.8	2.0/3.0	25/17	1.2:1	159	**SLQ-65**
300 - 600	0.5/0.8	0.6/1.2	3.0/6.0	25/15	1.3:1	159	**SLQ-K09**
428 - 473	0.2/0.4	0.5/0.9	1.0/3.0	25/17	1.3:1	159	**SLQ-67**
500-1000	0.6/0.9	1.0/1.5	4.0/8.0	20/13	1.5:1	159	**SLQ-K10**
736 - 814	0.2/0.4	0.5/0.9	2.0/4.0	25/15	1.3:1	159	**SLQ-78**
779 - 861	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.3:1	159	**SLQ-68**
836 - 924	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.3:1	159	**SLQ-69**
900 - 994	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.3:1	159	**SLQ-70**
1420 - 1570	0.3/0.6	0.7/1.0	3.0/5.0	17/13	1.3:1	159	**SLQ-71**
1496 - 1654	0.3/0.6	0.7/1.0	3.0/5.0	17/13	1.3:1	159	**SLQ-72**
1748 - 1932	0.3/0.6	0.7/1.0	3.0/5.0	17/13	1.3:1	159	**SLQ-73**

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**
6	1	2	5	3,4

*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally

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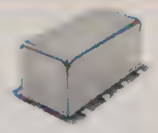
90° HYBRIDS



WIDEBAND SURFACE- MOUNT (8 Pin-Relay Header)

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	MODEL
3-32	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102S	**DQS-3-32**
5-50	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102S	**DQS-5-50**
10-50	0.8/1.0	0.5/0.9	1.5/3.0	30/20	1.3:1	102S	**DQS-10-50**
10-100	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102S	**DQS-10-100**
15-150	1.2/1.7	0.9/1.2	2.5/4.0	25/17	1.3:1	102S	**DQS-15-150**
20-100	0.8/1.0	0.5/0.8	1.5/3.0	30/20	1.3:1	102S	**DQS-20-100**
20-200	1.3/1.8	0.9/1.2	2.5/4.0	25/17	1.3:1	102S	**DQS-20-200**
25-250	1.5/2.0	0.9/1.2	2.5/4.0	25/17	1.3:1	102S	**DQS-25-250**
30-150	0.8/1.0	0.5/0.9	1.5/3.0	30/20	1.3:1	102S	**DQS-30-150**
30-300	1.5/2.0	1.0/1.4	3.0/5.0	25/16	1.3:1	102S	**DQS-30-300**
40-200	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	102S	**DQS-40-200**
40-400	1.7/2.2	1.0/1.5	3.0/5.0	25/16	1.3:1	102S	**DQS-40-400**
45-450	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	102S	**DQS-45-450**
50-250	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	102S	**DQS-50-250**
50-500	1.7/2.2	1.0/1.5	3.0/5.0	23/13	1.3:1	102S	**DQS-50-500**
60-300	0.9/1.0	0.6/1.0	2.0/4.0	30/18	1.3:1	102S	**DQS-60-300**
70-350	1.1/1.5	0.6/1.2	2.5/5.0	28/16	1.4:1	102S	**DQS-70-350**
80-400	1.2/1.5	0.6/1.25	3.0/5.0	25/16	1.4:1	102S	**DQS-80-400**
90-450	1.2/1.5	0.7/1.25	3.0/5.0	23/16	1.4:1	102S	**DQS-90-450**
100-500	1.2/1.5	0.8/1.25	3.0/5.0	25/16	1.4:1	102S	**DQS-100-500**

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**
1	8	7	2	3,4,5,6

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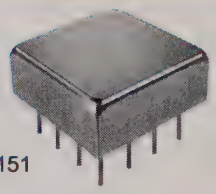
SYNERGY® MICROWAVE CORPORATION

90° HYBRIDS

WIDE BANDWIDTH
THROUGH HOLE MOUNT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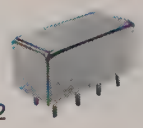
102

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
2-32	0.8/1.0	0.9/1.0	1.0/3.0	23/20	1.2:1	151	4	**DQP-2-16**
2-250	1.8/2.0	1.1/1.3	4.0/6.0	18/15	1.2:1	151	4	**DQP-2-125**
3-23	0.6/1.0	0.7/0.9	1.5/2.0	25/20	1.3:1	102	3	**DQP-2E2**
3-32	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102	3	**DQP-3-32**
5-50	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102	3	**DQP-5-50**
5.5-16.5	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	102	2	**DQP-301**
10-20	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	102	1	**DQP-206**
10-50	0.8/1.0	0.5/0.8	1.5/3.0	30/20	1.3:1	102	3	**DQP-10-50**
10-100	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	102	3	**DQP-10-100**
15-150	1.2/1.7	0.9/1.2	2.5/4.0	25/17	1.3:1	102	3	**DQP-15-150**
20-40	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	102	1	**DQP-201**
20-60	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	102	2	**DQP-302**
20-100	0.8/1.0	0.5/0.8	1.5/3.0	30/20	1.3:1	102	3	**DQP-20-100**
20-200	1.3/1.8	0.9/1.2	2.5/4.0	25/17	1.3:1	102	3	**DQP-20-200**
20-400	2.4/3.0	1.4/1.8	6.0/10	18/15	1.7:1	151	4	**DQP-2-200**
25-50	0.3/0.7	0.7/1.5	1.0/3.0	30/20	1.1:1	102	1	**DQP-2F1**
25-250	1.5/2.0	0.9/1.2	2.5/4.0	25/17	1.3:1	102	3	**DQP-25-250**
30-90	0.3/0.6	0.8/1.0	1.0/3.0	23/20	1.3:1	102	2	**DQP-303**
30-150	0.8/1.0	0.5/1.0	1.5/3.0	30/20	1.3:1	102	3	**DQP-30-150**
30-300	1.5/2.0	1.0/1.4	3.0/5.0	25/16	1.3:1	102	3	**DQP-30-300**
40-70	0.3/0.7	0.4/1.5	1.0/3.0	30/20	1.1:1	102	1	**DQP-2H1**
40-80	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	102	1	**DQP-202**
40-120	0.3/0.6	0.8/1.2	2.0/4.0	23/17	1.4:1	102	2	**DQP-305**
40-200	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	102	3	**DQP-40-400**
45-450	1.7/2.2	1.0/1.4	3.0/5.0	25/15	1.3:1	102	3	**DQP-45-450**
50-250	0.9/1.0	0.5/0.8	2.0/4.0	30/18	1.3:1	102	3	**DQP-50-250**
50-500	1.7/2.2	1.0/1.4	3.0/5.0	23/13	1.3:1	102	3	**DQP-50-500**
52-88	0.3/0.6	0.2/0.5	1.0/2.5	25/20	1.1:1	102	1	**DQP-220**
55-90	0.3/0.7	0.6/1.2	1.0/3.0	30/20	1.2:1	102	1	**DQP-223**
60-80	0.2/0.6	0.2/0.45	1.0/2.5	30/20	1.1:1	102	1	**DQP-222**
60-300	0.9/1.0	0.6/0.8	2.0/4.0	30/18	1.3:1	102	3	**DQP-60-300**
70-350	1.1/1.5	0.6/1.0	2.5/5.0	28/16	1.3:1	102	3	**DQP-70-350**
80-120	0.3/0.7	0.7/1.5	1.0/3.0	25/18	1.1:1	102	1	**DQP-2A2**
80-160	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	102	1	**DQP-203**
90-270	0.4/0.7	0.8/1.2	2.0/4.0	23/17	1.5:1	102	2	**DQP-304**
90-450	1.2/1.5	0.7/1.0	3.0/5.0	23/16	1.3:1	102	3	**DQP-90-450**
100-200	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	102	1	**DQP-204**
100-500	1.2/1.5	0.8/1.0	3.0/5.0	25/16	1.3:1	102	3	**DQP-100-500**
104-176	0.3/0.6	0.2/0.6	1.0/2.5	25/20	1.1:1	102	1	**DQP-221**
115-345	0.5/0.8	0.8/1.4	2.0/4.0	20/17	1.5:1	102	2	**DQP-310**
150-300	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	102	1	**DQP-205**
225-400	0.5/0.8	1.0/1.5	2.0/4.0	22/17	1.2:1	102	1	**DQP-207**
240-720	0.7/1.0	1.2/1.6	3.0/5.0	20/15	1.5:1	102	2	**DQP-330**

PIN-OUT TABLE

	INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**
#1	1	2	5	6	3,4,7,8
#2	1	6	2	5	3,4,7,8
#3	1	8	7	2	3,4,5,6
#4	1	3	4	2	5,6

*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally

Power Rating: 1 Watt, max.
All specifications assume 50 ohm impedance of all ports
For pin location and package outline drawings, see back pages.

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MINIATURE LEADLESS SURFACE-MOUNT

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.2-11.2	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-51**
19-21	0.2.0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-57**
20.4 -22.4	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-52**
28.5 -31.5	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-53**
38-42	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-58**
57-63	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-54**
66.5 -73.5	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-56**
76-84	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-61**
95-105	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-62**
114-126	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-66**
133-147	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	134	1	**SQ-63**
190-210	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.2:1	134	1	**SQ-64**
285-315	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.2:1	134	1	**SQ-65**
427.5-477.5	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.2:1	134	1	**SQ-67**
779 - 861	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.2:1	134	1	**SQ-68**
836 - 924	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.2:1	134	1	**SQ-69**
900 - 994	0.2/0.5	0.5/0.9	2.0/4.0	25/15	1.2:1	134	1	**SQ-70**

THROUGH HOLE MOUNT (8 Pin-Relay Header)

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
1.13-1.38	0.4/0.7	0.6/1.2	1.0/3.0	29/25	1.1:1	102	2	**DQP-2A1**
9-11	0.4/0.7	0.6/1.2	1.0/3.0	25/20	1.1:1	102	2	**DQP-2B1**
10.2-11.2	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-251**
16-19	0.6/0.7	0.7/1.6	1.0/3.0	28/25	1.1:1	102	2	**DQP-2C1**
19-21	0.2.0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-257**
20-23	0.4/0.7	0.6/1.2	1.0/3.0	35/20	1.1:1	102	2	**DQP-2E1**
20.4 -22.4	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-252**
57-63	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-254**
66.5 -73.5	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-256**
76-84	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-261**
95-105	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-262**
114-126	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-266**
133-147	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-263**
190-210	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-264**
285-315	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-265**
427.5-477.5	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.1:1	102	2	**DQP-267**

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**
#1	6	1	2	5	3,4
#2	1	2	5	6	3,4,7,8

*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally

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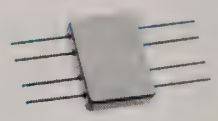

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
5.5-16.5	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	101	1	DQF-301
7-14	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	101	1	DQF-1B1
10-20	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	101	1	DQF-106
10.2 -11.2	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-151
19-21	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-157
20-40	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	101	1	DQF-101
20-60	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	101	1	DQF-302
20.33-22.47	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-152
28.5-31.5	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-153
30-90	0.3/0.6	0.8/1.0	1.0/3.0	23/20	1.3:1	101	1	DQF-303
38-42	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-158
40-80	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	101	1	DQF-102
40-120	0.3/0.6	0.8/1.2	2.0/4.0	23/17	1.4:1	101	1	DQF-305
52-88	0.3/0.6	0.2/0.5	1.0/2.5	25/20	1.1:1	101	1	DQF-120
55-90	0.3/0.7	0.6/1.2	1.0/3.0	30/20	1.2:1	101	1	DQF-123
57-63	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-154
60-80	0.2/0.6	0.2/0.45	1.0/2.5	30/20	1.1:1	101	1	DQF-122
66.5-73.5	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-156
76-84	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-161
80-160	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	101	1	DQF-103
90-270	0.4/0.7	0.8/1.2	2.0/4.0	23/17	1.5:1	101	1	DQF-304
95-105	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-162
100-200	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	101	1	DQF-104
104-176	0.3/0.6	0.2/0.6	1.0/2.5	25/20	1.1:1	101	1	DQF-121
115-345	0.5/0.8	0.8/1.4	2.0/4.0	20/17	1.5:1	101	1	DQF-310
114-126	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-166
133-147	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-163
150-300	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	101	1	DQF-105
190-210	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-164
240-720	0.7/1.0	1.2/1.6	3.0/5.0	20/15	1.5:1	101	1	DQF-330
285-315	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-165
430-470	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	101	1	DQF-167

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*	GROUND**
#1	1	8	5	4	2,3,6,7

*Terminate isolated port with 50 ohms externally
**GROUND = Ground externally

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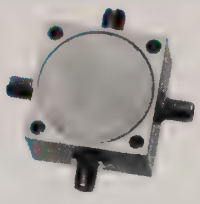

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.2-10.5	0.2.0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-751*
5.5-16.5	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	113	2	DQK-301*
10-20	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	113	1	DQK-706*
19-21	0.2.0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-757*
20-40	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	113	1	DQK-701*
20-60	0.3/0.5	0.8/1.0	1.0/3.0	23/20	1.3:1	113	2	DQK-302*
20.35-22.4	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-752*
28.5-31.5	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-753*
30-90	0.3/0.6	0.8/1.0	1.0/3.0	23/20	1.3:1	113	2	DQK-303*
38-42	0.2.0.3	0.5-0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-758*
40-80	0.3/0.6	0.4/0.75	1.0/3.0	25/20	1.1:1	113	1	DQK-702*
40-120	0.3/0.6	0.8/1.2	2.0/4.0	23/17	1.4:1	113	2	DQK-305*
52-88	0.3/0.6	0.2/0.5	1.0/2.5	25/20	1.1:1	113	1	DQK-720*
55-90	0.3/0.7	0.6/1.2	1.0/3.0	30/20	1.2:1	113	1	DQK-723*
57-63	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-754*
60-80	0.2/0.6	0.2/0.45	1.0/2.5	30/20	1.1:1	113	1	DQK-722*
66.5-73.5	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-756*
76-84	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-761*
80-160	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	113	1	DQK-703*
90-270	0.4/0.7	0.8/1.3	2.0/4.0	23/17	1.5:1	113	2	DQK-304*
95-105	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-762*
100-200	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	113	1	DQK-704*
104-176	0.3/0.6	0.2/0.6	1.0/2.5	25/20	1.1:1	113	1	DQK-721*
115-345	0.5/0.8	0.8/1.4	2.0/4.0	20/17	1.5:1	113	2	DQK-310*
114-126	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-766*
133-147	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-763*
150-300	0.4/0.75	0.5/1.0	1.0/3.0	25/20	1.1:1	113	1	DQK-705*
190-210	0.2/0.3	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-764*
240-720	0.7/1.0	1.2/1.6	3.0/5.0	20/15	1.5:1	113	2	DQK-330*
285-315	0.2/0.4	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-765*
430-470	0.2/0.6	0.5/0.7	1.0/3.0	25/20	1.1:1	113	1	DQK-767*

Power Rating: 1 Watt, max.
All specifications assume 50 ohms impedance of all ports
*Select Connector Sufix: "B" = BNC, "S = SMA, 'N" = TYPE N, "T" = TNC
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	+90° OUTPUT	0° OUTPUT	ISOLATED*
#1	1	2	4	3
#2	1	3	2	4

*Terminate isolated port with 50 ohms externally

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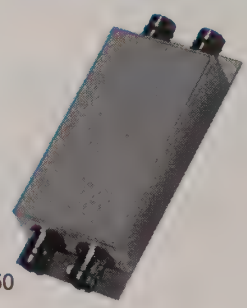
SYNERGY® MICROWAVE CORPORATION

90° HYBRIDS

MULTI-OCTAVE BANDWIDTH
COAXIAL CONNECTOR MODELS

113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FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) TYP/MAX	AMPLITUDE UNBALANCE (dB) TYP/MAX	PHASE UNBALANCE (Degrees) TYP/MAX	ISOLATION (dB) TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
2-32	0.8/1.0	0.9/1.0	1.0/3.0	23/20	1.3:1	150	2	**DQK-2-16B**
2-250	1.8/2.0	1.1/1.3	4.0/6.0	18/15	1.4:1	150	2	**DQK-2-125B**
3-32	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	113	1	**DQK-3-32S**
5-50	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	113	1	**DQK-5-50S**
10-50	0.8/1.0	0.5/0.8	1.5/3.0	30/20	1.3:1	113	1	**DQK-10-50S**
10-100	1.0/1.5	0.9/1.2	2.0/3.0	25/20	1.3:1	113	1	**DQK-10-100S**
15-150	1.2/1.7	0.9/1.2	2.5/4.0	25/17	1.3:1	113	1	**DQK-15-150S**
20-100	0.8/1.0	0.5/1.0	1.5/3.0	30/20	1.3:1	113	1	**DQK-20-100S**
20-200	1.3/1.8	0.9/1.2	2.5/4.0	25/17	1.3:1	113	1	**DQK-20-200S**
20-400	2.4/3.0	1.4/1.8	6.0/10	18/15	1.7:1	150	2	**DQK-2-200B**
25-250	1.5/2.0	0.9/1.2	2.5/4.0	25/17	1.3:1	113	1	**DQK-25-250S**
30-150	0.8/1.0	0.5/1.0	1.5/3.0	30/20	1.3:1	113	1	**DQK-30-150S**
30-300	1.5/2.0	1.0/1.4	3.0/5.0	25/16	1.3:1	113	1	**DQK-30-300S**
40-200	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	113	1	**DQK-40-400S**
45-450	1.7/2.2	1.0/1.5	3.0/5.0	25/15	1.3:1	113	1	**DQK-45-450S**
50-250	0.9/1.0	0.5/1.0	2.0/4.0	30/18	1.3:1	113	1	**DQK-50-250S**
50-500	1.7/2.2	1.0/1.5	3.0/5.0	23/13	1.3:1	113	1	**DQK-50-500S**
60-300	0.9/1.0	0.6/1.0	2.0/4.0	30/18	1.3:1	113	1	**DQK-60-300S**
70-350	1.1/1.5	0.6/1.0	2.5/5.0	28/16	1.3:1	113	1	**DQK-70-350S**
90-450	1.2/1.5	0.7/1.2	3.0/5.0	23/16	1.3:1	113	1	**DQK-90-450S**
100-500	1.2/1.5	0.8/1.2	3.0/5.0	25/16	1.3:1	113	1	**DQK-100-500S**

Power Rating (All Models) = 1 Watt, max
Connector Sufix: "B" = BNC, "S = SMA, (Last letter in Model number)
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	0° OUTPUT	+90° OUTPUT	*ISOLATED
# 1	1	4	3	2
# 2	1	2	3	4

*Terminate isolated port with 50 ohms externally.

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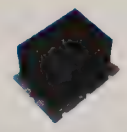
SYNERGY® MICROWAVE CORPORATION

180° HYBRIDS

SURFACE-MOUNT



3 - PORT

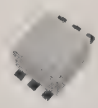
FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
5 - 400	28/23	28/23	25/20	1.1/1.6	1.5/2.0	1.9/2.3	2.0	4.0	4.0	0.3	0.5	0.7	152	2	SMJ-C2
50 - 750	22/17	20/15	18/13	1.5/2.2	1.6/2.4	1.9/2.7	4.0	4.0	4.0	0.5	0.4	0.7	152	2	SMJ-C4
20 - 1000	21/16	17/12	15/10	2.5/3.2	2.2/3.0	2.5/3.2	3.5	5.5	7.5	1.0	0.6	1.0	152	2	SMJ-C5

LEADED SURFACE-MOUNT

3 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2 - 200	25/20	30/20	25/20	1.0/1.3	0.8/1.0	1.0/1.3	1.0	3.0	5.0	0.3	0.3	0.3	159	1	SJL-113

LEADED SURFACE-MOUNT



4 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2 - 200	25/20	30/20	25/20	1.0/1.3	0.8/1.0	1.0/1.3	1.0	3.0	5.0	0.3	0.3	0.3	159	3	SJL-123

Power Rating (All Models) = 1 Watt, max.
Impedance is 50 Ohms

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	0° OUTPUT	180° OUTPUT	ISOLATED*	GROUND
#1	6	4	3	---	1,2,5
#2	3	1	2	---	4,5,6
#3	6	4	3	1	2,5

*Terminate Isolated Port in 50 Ohms
GROUND = Ground externally

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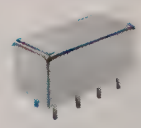
SYNERGY® MICROWAVE CORPORATION

180° HYBRIDS

THROUGH HOLE MOUNT(8-Pin Relay Header)



3 - PORT

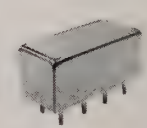
FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-20	25/20	30/25	27/23	0.5/0.8	0.3/0.5	0.5/0.7	2.0	2.0	2.0	0.2	0.2	0.2	102	1	DJP-201
1-200	35/30	35/25	30/23	.75/1.0	0.5/0.8	.75/1.2	2.0	2.5	4.0	.15	.15	0.3	102	1	DJP-2A2
5-200	30/25	30/25	30/25	1.0/1.2	1.0/1.2	1.0/1.4	2.0	3.0	4.0	0.1	0.2	0.2	102	1	DJP-203
5-400	28/23	28/23	25/20	0.9/1.4	1.2/1.7	1.7/2.0	1.5	3.0	6.0	0.3	0.4	0.5	102	1	DJP-204

THROUGH HOLE MOUNT(TO-8)

3 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-20	25/20	30/25	27/23	0.5/0.8	0.3/0.5	0.5/0.7	2	2	2	0.2	0.2	0.2	122	2	DJP-601
5-200	30/25	30/25	30/25	1.0/1.2	1.0/1.2	1.0/1.4	2	3	4	0.1	0.2	0.2	122	2	DJP-603
5-400	28/23	28/23	25/20	0.9/1.4	1.2/1.7	1.7/2.0	1.5	3	6	0.3	0.4	0.5	122	2	DJP-604

THROUGH HOLE MOUNT(8 Pin Relay Header)



4 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2-200	30/25	28/23	25/20	0.5/0.9	0.7/1.0	0.8/1.2	1	2	3	0.1	0.2	0.3	102	3	DJP-202
2-400	22/18	23/18	20/15	1.4/1.8	1.2/2.0	1.6/2.5	1	3	5	0.1	0.2	0.3	102	3	DJP-205

Power Rating (All Models) = 1 Watt, max
Impedance is 50 Ohms
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	0° OUTPUT	180° OUTPUT	ISOLATED*	GROUND
#1	1	5	6	---	All other
#2	2	1	4	---	3
#3	1	5	6	2	All other

*Terminate Isolated Port in 50 Ohms
GROUND = Ground externally

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SYNERGY® MICROWAVE CORPORATION

180° HYBRIDS

3 - PORT

FLAT-PACK

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
5-200	30/25	30/25	30/25	1.0/1.2	1.0/1.2	1.0/1.4	2	3	4	0.1	0.2	0.2	101	1	DJF-103
5-400	28/23	28/23	25/20	0.9/1.4	1.2/1.7	1.7/2.0	1.5	3	6	0.3	0.4	0.5	101	1	DJF-104

4 - PORT

FLAT-PACK

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2-200	30/25	28/23	25/20	0.5/0.9	0.7/1.0	0.8/1.2	1	2	3	0.1	0.2	0.3	101	2	DJF-102
2-400	22/15	23/18	20/15	1.4/1.8	1.2/2.0	1.6/2.5	1	3	5	0.1	0.2	0.3	101	2	DJF-105

Power Rating (All Models) = 1 Watt, max.
Impedance is 50 Ohms.
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	0° OUTPUT	180° OUTPUT	ISOLATED*	GROUND
#1	1	4	8	---	All other
#2	1	4	8	5	All other

*Terminate Isolated Port in 50 Ohms
GROUND = Ground externally

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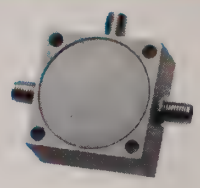
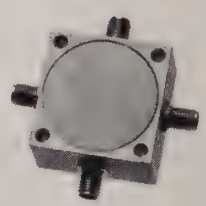
180° HYBRIDS



COAXIAL CONNECTOR

3 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
0.01-20	25/20	30/25	27/23	0.5/0.8	0.3/0.5	0.5/0.7	2	2	2	0.2	0.2	0.2	110	1	**DJK-701***
5-200	30/25	30/25	30/25	1.0/1.2	1.0/1.2	1.0/1.4	2	3	4	0.1	0.2	0.2	110	1	**DJK-703***
5-400	28/23	28/23	25/20	0.9/1.4	1.2/1.7	1.7/2.0	1.5	3	6	0.3	0.4	0.5	110	1	**DJK-704***
50 -1000	23/15	20/15	18/12	1.9/2.8	2.3/2.8	2.5/2.8	5	7	10	0.5	0.7	1.0	110	1	**DJK-706***



COAXIAL CONNECTOR

4 - PORT

FREQUENCY RANGE (MHz)	ISOLATION (dB)			INSERTION LOSS (dB)			PHASE UNBALANCE (Degrees)			AMPLITUDE UNBALANCE (dB)			PACKAGE	PIN-OUT (See Below)	MODEL
LF-HF	LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	LB MAX	MB MAX	UB MAX	LB MAX	MB MAX	UB MAX			
2-200	30/25	28/23	25/20	0.5/0.9	0.7/1.0	0.8/1.2	1	2	3	0.1	0.2	0.3	113	2	**DJK-702***
2-400	22/18	23/18	20/15	1.4/1.8	1.2/2.0	1.6/2.5	1	3	5	0.1	0.2	0.3	113	2	**DJK-705***

*Select Connector Sufix: "B" = BNC, "S = SMA, 'N" = TYPE N, "T" = TNC
Power Rating (All Models) = 1 Watt, max
Impedance is 50 Ohms.
For pin location and package outline drawings, see back pages.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

PIN-OUT TABLE

	INPUT	0° OUTPUT	180° OUTPUT	ISOLATED*	GROUND
#1	2	1	3	-	-
#2	1	2	4	3	-

*Terminate Isolated Port in 50 Ohms
GROUND = Ground externally

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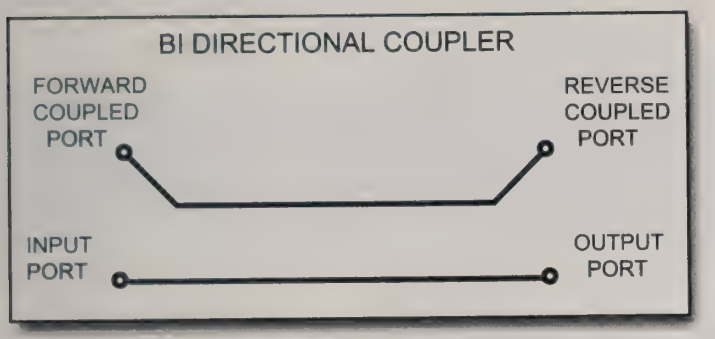
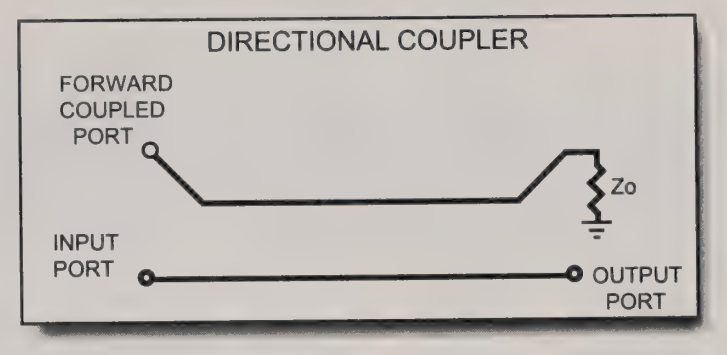
SYNERGY® MICROWAVE CORPORATION

COUPLERS

Synergy's line of couplers consist of directional & bidirectional types with frequencies ranging from 10 KHz to 2 GHz. A bidirectional coupler is a 4 port device that produces two unequal amplitude outputs when a signal is fed through the input port and cancels the signal at the reverse coupled port. A directional coupler has the reverse coupled port internally terminated.

Couplers are categorized by the low signal level output. A 10 dB directional coupler will provide an output of 10 dB below the input signal level, and a "Main Line" signal level which has very little loss (0.46 dB theoretically). Listed below are the functional diagrams for both types.





PARAMETER DEFINITIONS

Coupling

Coupling is the attenuation in dB of a signal at a coupled port relative to the input port.

Coupling Flatness

Coupling flatness is the peak to peak variation in coupling over the specified frequency range.

Insertion Loss

Insertion loss is the unrecoverable power in dB dissipated within the circuit.

Coupling Loss

Theoretically, the RF power will split unevenly between the mainline and coupling port. Listed in Table 1 is the coupling loss for Synergy's line of directional couplers.

Mainline Loss

Mainline loss is equal to insertion loss plus the coupling loss.

Table 1

Coupling Value	Coupling loss
6 dB	1.25 dB
10 dB	0.46 dB
15 dB	0.140 dB
20 dB	0.044 dB

Directivity

Directivity is a measure of the coupler's ability to direct energy only to the desired port. Directivity is equal to the isolation value minus the coupling value.

VSWR

The voltage standing wave ratio is a term used to indicate how well the device is matched to the system impedance.

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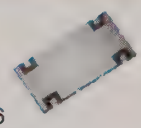
DIRECTIONAL COUPLERS

SURFACE-MOUNT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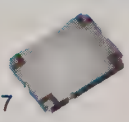
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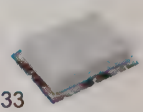
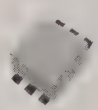
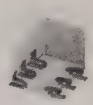

133

147

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.5 ± 1.0	0.5 - 500	± 0.7	1.0/1.4	0.8/1.4	1.0/1.6	28/23	25/20	20/15	1.3:1	133	2	SDC-C1
10.5 ± 0.5	10 - 500	± 0.4	0.8/1.2	0.8/1.3	1.0/1.5	33/23	25/20	20/15	1.3:1	133	2	SDC-C2
10.7 ± 1.0	800 -1550	± 1.0	---/---	---/---	2.0/3.5	---/---	---/---	20/10	1.5:1	147	4	SDC-M-3♦
10.5 ± 0.5	2100 - 2400	± 0.3	---/---	---/---	1.0/1.4	---/---	---/---	22/15	1.4:1	216	6	SDC-2124♦
11.5 ± 0.5	5 - 1000	± 0.5	1.5/1.8	1.6/1.9	1.7/2.0	25/20	24/18	22/15	1.3:1	133	2	SDC-C3
11.0 ± 1.0	100 -1000	± 0.6	---/---	1.5/1.8	1.6/2.0	---/---	25/20	20/15	1.3:1	147	4	SDC-M-2
11.5 ± 0.5	850 - 950	± 0.4	---/---	---/---	1.6/2.0	---/---	---/---	25/20	1.2:1	133	2	SDC-C1-1
15.0 ± 0.75	40 - 860	± 0.7	1.0/1.5	---/---	1.0/1.5	18/15	---/---	18/15	1.35:1	133	2	SDC-C4
20.0 ± 1.0	100 - 1000	± 0.75	0.3/0.6	0.5/0.9	0.9/1.5	35/25	28/20	20/13	1.3:1	147	4	SDC-M-1
21.5 ± 1.0	800 - 1000	± 0.6	---/---	---/---	0.3/0.5	---/---	---/---	22/15	1.2:1	133	2	SDC-C5♦
21.5 ±1.0	800 - 1000	± 0.5	---/---	---/---	0.4/0.6	---/---	---/---	22/15	1.4:1	217	6	SDC-8010♦

LEADED SURFACE-MOUNT


159


134S

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.0 ± 0.5	30 - 1000	± 0.6	1.5/1.8	1.5/1.8	1.5/1.8	20/15	20/15	20/15	1.5:1	159	1	SCL-4B-75■
10.0 ± 0.5	30 - 1000	± 0.6	1.5/1.8	1.5/1.8	1.5/1.8	20/15	20/15	20/15	1.5:1	134S	1	SCZ-4B-75■
10.5 ± 0.5	10 - 500	± 0.4	0.8/1.2	0.8/1.3	1.0/1.5	33/23	25/20	20/15	1.3:1	134S	1	SCZ-2B
11.5 ± 0.5	5 - 1000	± 0.5	1.5/1.8	1.6/1.9	1.7/2.0	25/20	24/18	22/15	1.3:1	134S	1	SCZ-3B
11.5 ± 0.5	5 - 1000	± 0.5	1.5/1.8	1.6/1.9	1.7/2.0	25/20	24/18	22/15	1.3:1	159	1	SCL-3B
11.5 ± 0.5	850 - 950	± 0.4	---/---	---/---	1.6/2.0	---/---	---/---	25/20	1.2:1	134S	1	SCZ-1-1
11.5 ± 0.5	950 -1525	± 0.7	---/---	---/---	2.0/2.8	---/---	---/---	20/15	1.3:1	159	3	SCL-7B-75■
11.5 ± 0.5	950 -1525	± 0.7	---/---	---/---	2.0/2.8	---/---	---/---	20/15	1.3:1	134S	3	SCZ-7B-75■
15.0 ± 0.75	40 - 860	± 0.7	1.0/1.5	---/---	1.0/1.5	18/15	---/---	18/15	1.35:1	134S	1	SCZ-4C
20.0 ± 1.0	50 - 750	± 1.0	0.2/0.5	0.2/0.5	0.2/0.5	20/15	20/15	20/15	1.5:1	159	1	SCL-4D-75■
20.0 ± 1.0	50 - 750	± 1.0	0.2/0.5	0.2/0.5	0.2/0.5	20/15	20/15	20/15	1.5:1	134S	1	SCZ-4D-75■
20.0 ± 1.0	800 - 900	± 0.4	---/---	---/---	1.0/1.8	---/---	---/---	15/10	1.3:1	159	3	SCL-6D

Power rating (all models) = 1 Watt, max
■ 75 Ohm Models
Impedance, unless otherwise noted is 50 ohms.
♦ (UB) - Denotes full bandwidth specification
For pin location and package outline drawings, see back pages.

LB=LF to 10 L F
MB=10 LF to HF/2
UB=HF/2 to HF

PIN-OUT TABLE

	IN	OUT	COUPLED	GND	NO CONN.	* ISOLATED
#1	6	1	4	2,5	3	-
#2	1	2	3	4,5,6	-	-
#3	1	2	5	6,4,3	-	-
#4	1	2	3	-	4	-
#5	1	2	5	3,6	-	4
#6	1	2	4	-	-	3

* Terminate isolated port with 50 ohms.

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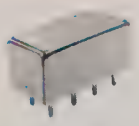
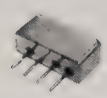
DIRECTIONAL COUPLERS



THROUGH HOLE (8 Pin Relay)

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
6.0 ± 0.5	10 - 100	± 0.25	1.6/1.8	---/---	1.8/2.0	40/30	---/---	30/25	1.5:1	102	1	KAP-201
10.5 ± 0.5	1 - 2000	± 1.0	1.2/1.9	1.3/1.9	2.0/2.5	38/25	30/18	22/18	1.3:1	102	1	KBP-2A6***
10.5 ± 0.5	1 - 250	± 0.75	1.1/1.5	---/---	1.1/1.5	30/20	---/---	30/20	2.0:1	102	1	KBP-2A2
10.5 ± 0.5	250 -1000	± 0.6	1.4/1.6	---/---	1.6/2.0	30/25	30/20	25/15	1.5:1	102	1	KBP-2A4**
11.0 ± 0.5	5 - 750	± 0.5	1.1/1.6	1.2/1.7	1.6/1.9	35/30	25/20	25/20	1.25:1	102	1	KBP-2B4
11.0 ± 0.75	5 - 1000	± 0.5	1.5/1.8	1.6/1.9	1.7/2.0	40/30	25/20	25.20	1.2:1	102	1	KBP-204
11.5 ± 0.5	0.5 - 500	± 0.6	.85/1.3	.65/1.0	.85/1.3	32/15	32/25	22/15	1.2:1	102	1	KBP-2A1
11.5 ± 0.5	1 - 500	± 0.6	0.9/1.2	0.8/1.2	1.1/1.3	25/20	25/18	23/15	1.2:1	102	1	KBP-203
15.0 ± 0.5	0.01 - 35	± 0.5	0.3/0.6	0.2/0.4	0.3/0.6	38/30	35/25	28/20	1.15:1	102	1	KCP-2B1
15.0 ± 0.75	0.5 - 1000	± 0.7	0.8/1.2	0.6/1.2	1.0/1.5	33/25	25/20	18/15	1.35:1	102	1	KCP-204
19.5 ± 0.5	1 - 150	± 0.75	.35/0.8	.35/0.8	.35/0.8	25/20	25/20	25/20	2.0:1	102	1	KDP-2B2■
19.5 ± 0.5	0.2 - 250	± 0.5	0.2/0.5	0.2/0.4	0.3/0.6	40/28	38/25	32/20	1.2:1	102	1	KDP-202
20.0 ± 0.5	0.5 - 1000	± 0.8	0.2/0.6	0.4/1.0	1.0/1.7	27/20	20/15	20/15	1.3:1	102	1	KDP-204
20.0 ± 1.0	5 - 500	± 0.7	0.2/0.5	0.3/0.8	0.4/1.0	35/25	25/18	20/15	1.3:1	102	1	KDP-203
21.0 ± 0.75	25 - 400	± 0.5	0.2/.25	---/---	.35/0.5	25/20	---/---	25/20	1.25:1	102	1	KDP-213*



THROUGH HOLE (4-Pin Mini Relay)

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
6.0 ± 0.5	10 - 100	± 0.25	1.6/1.8	---/---	1.8/2.0	40/30	---/---	30/25	1.5:1	106	2	KAP-301
6.3 ± 0.4	10 - 400	± 0.4	2.0/2.4	2.0/2.4	2.0/2.5	36/30	30/25	20/15	1.5:1	106	2	KAP-302
10.5 ± 0.5	1 - 400	± 0.5	0.8/1.0	0.9/1.2	1.0/1.5	30/23	25/20	20/15	1.4:1	106	2	KBP-313
10.5 ± 1.0	0.5 - 500	± 0.7	1.0/1.2	0.8/1.2	1.0/1.3	28/20	25/18	18/15	1.4:1	106	2	KBP-303
11.0 ± 0.5	5 - 1000	± 0.6	1.4/1.8	1.5/1.8	1.6/2.0	35/25	25/20	20/15	1.5:1	106	2	KBP-314
20.0 ± 1.0	5 - 500	± 0.7	0.2/0.5	0.3/0.8	0.4/1.0	35/25	25/18	20/15	1.3:1	106	2	KDP-303

Power rating (all models) = 1 Watt, max
* LB = 25 - 50 MHz, MB = 50 - 300 MHz, UB = 300 - 400 MHz
** LB = 250 - 500 MHz, MB = 500 - 750 MHz, UB = 750 - 1000 MHz
*** Input Power = 0.5 Watts Max.
■ 75 Ohm models
For pin location and package outline drawings, see back pages.

LB=LF to 10 LF
MB=10 LF to HF/2
UB=HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	COUPLED	CASE GND	NO CONN
#1	1	4	3	2,5,7,8	6
#2	1	2	4	3	-

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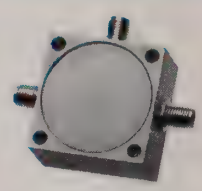
DIRECTIONAL COUPLERS



COAXIAL CONNECTOR

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.0 ± 1.0	2 - 100	± 0.5	0.6/0.8	0.7/0.9	0.8/1.0	36/30	38/30	36/30	1.2:1	110	1	**KBK-701***
10.5 ± 0.5	1 - 2000	± 1.0	1.2/1.9	1.3/1.9	2.0/2.5	38/25	30/18	22/18	1.3:1	110	1	**KBK-7A6S*****
10.5 ± 0.5	1 - 250	± 0.75	0.7/1.0	0.9/1.2	1.0/1.5	35/25	35/20	25/20	1.2:1	110	1	**KBK-7A2B ■**
10.75 ± 0.25	1 - 500	± 0.6	1.0/1.3	0.9/1.2	1.1/1.3	25/20	25/18	22/15	1.3:1	110	1	**KBK-703***
11.0 ± 1.0	5 - 1000	± 1.0	1.8/2.0	1.6/2.0	1.4/2.0	32/25	28/23	26/20	1.4:1	110	1	**KBK-704***
11.0 ± 0.5	1 - 1000	± 0.5	1.2/1.7	1.2/1.7	1.6/2.0	40/30	25/20	25/20	1.2:1	110	1	**KBK-7C4***
11.5 ± 0.5	10 - 1000	± 0.75	1.4/1.6	1.4/1.7	1.5/1.7	40/30	35/25	28/23	1.5:1	110	1	**KBK-705***
15.0 ± 0.5	0.01 - 35	± 0.5	0.3/0.6	0.2/0.4	0.3/0.6	38/30	35/25	28/20	1.15:1	110	1	**KCK-7C1***
15.0 ± 1.0	2 - 100	± 0.5	.25/0.4	.25/0.4	.25/0.4	37/30	35/30	33/28	1.09:1	110	1	**KCK-701***
15.0 ± 1.0	10 - 500	± 0.75	0.6/0.9	0.6/1.0	.75/1.15	33/25	35/25	30/25	1.3:1	110	1	**KCK-703***
15.0 ± 1.0	5 - 1000	± 0.75	0.6/0.9	0.9/1.3	1.2/1.65	30/23	33/23	25/20	1.3:1	110	1	**KCK-704***
19.5 ± 0.5	0.2 - 250	± 0.25	0.2/0.4	0.2/0.4	.22/0.6	40/30	40/25	35/20	1.1:1	110	1	**KDK-702***
19.8 ± 0.5	1 - 1000	± 0.5	0.3/0.6	.35/0.7	1.2/1.5	35/28	32/25	24/18	1.3:1	110	1	**KDK-704***
20.0 ± 1.0	0.5 - 120	± 0.5	.15/.20	.18/.23	.21/.25	40/30	35/30	33/30	1.08:1	110	1	**KDK-701***
20.0 ± 1.0	10 - 500	± 0.8	0.2/0.4	0.2/0.6	0.3/0.8	35/30	35/28	35/25	1.2:1	110	1	**KDK-703***
20.0 ± 1.0	1 - 1000	± 0.5	0.3/0.6	0.3/0.7	0.9/1.2	35/28	32/25	24/18	1.3:1	110	1	**KDK-705***

Power rating (all models) = 1 Watt, max
* Select female connector suffix: "S" = SMA, "B" = BNC, "N" = Type N, "T" = TNC
*** Input Power = 0.5 Watts Max.
For pin location and package outline drawings, see back pages.

■ 75 Ohm models

LB=LF to 10 LF
MB=10 LF to HF/2
UB=HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	COUPLED	CASE GND	NO CONN
#1	3	1	2	-	-
#2	2	3	1	-	-

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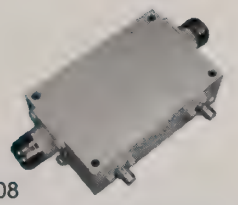
COAXIAL CONNECTOR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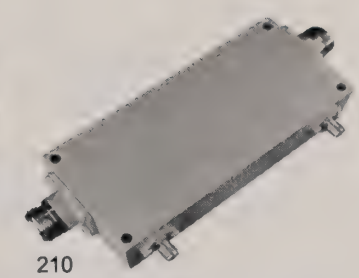
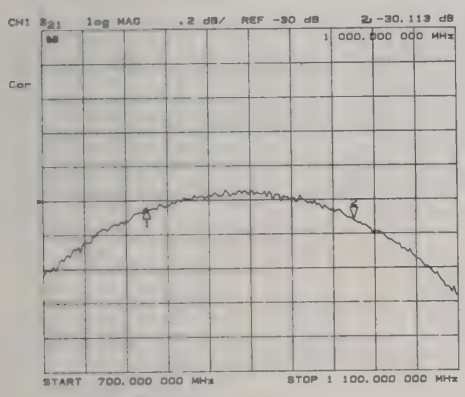
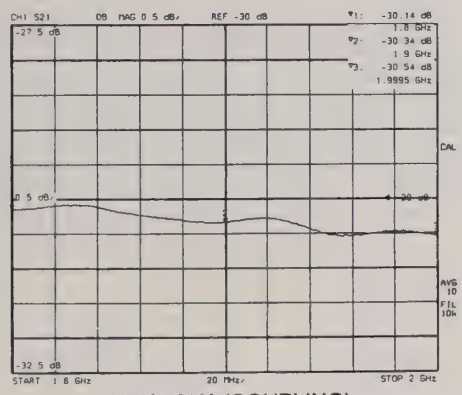

210

COUPLING (dB) NOM.	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) MAX.	DIRECTIVITY (dB) MIN.	INPUT POWER MAX.	VSWR TYP	IMPEDANCE (OHMS)	PACKAGE	MODEL
30.0 ± 1.0	800 - 2000	± 0.4	0.4	20	100	1.25:1	50	210	**KEK-706H**
30.0 ± 0.75	850 - 960	± 0.25	0.2	30	500	1.15:1	50	207	**KEK-704H**
30.0 ± 0.75	1800 - 2000	± 0.25	0.2	30	500	1.15:1	50	208	**KEK-705H**

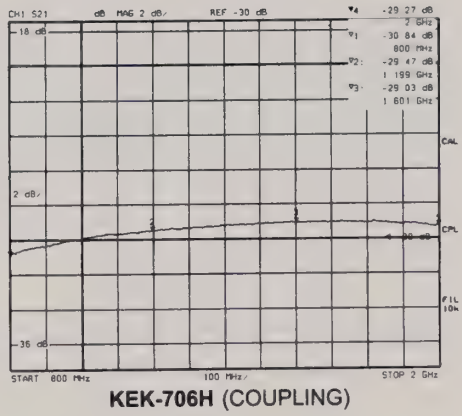
For pin location and package outline drawings, see back pages.



KEK-704H (COUPLING)



KEK-705H (COUPLING)



KEK-706H (COUPLING)

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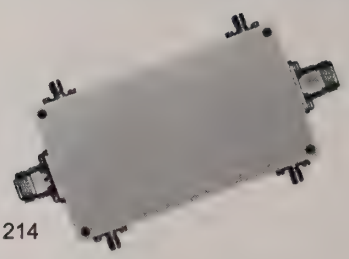
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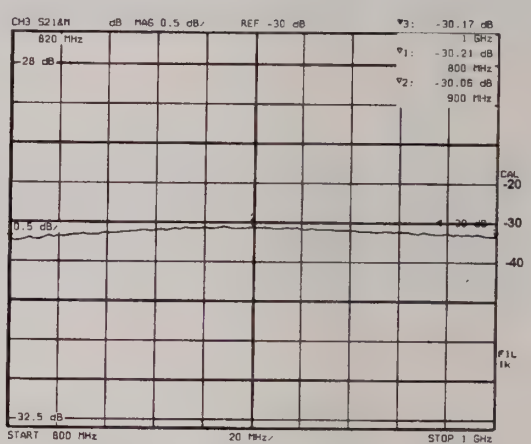
Coaxial Connector

COUPLING (dB) NOM.	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) MAX.	DIRECTIVITY (dB) MIN.	INPUT POWER MAX.	VSWR TYP	IMPEDANCE (OHMS)	PACKAGE	MODEL
30.0 ± 0.75	850 - 960	± 0.25	0.2	30	500	1.15:1	50	214	**KEK-704DH**

For pin location and package outline drawings, see back pages.



KEK-704DH (COUPLING)

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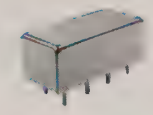
SYNERGY® MICROWAVE CORPORATION

BI-DIRECTIONAL COUPLERS

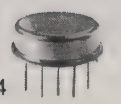


THROUGH HOLE (8 Pin Relay Header)

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
6.0 ± 0.5	10 - 100	± 0.25	1.5/2.0	1.5/2.0	1.5/2.0	30/25	30/25	30/25	1.2:1	120	1	**KAP-241**
11.5 ± 1.0	0.5 - 400	± 1.0	0.8/1.0	0.7/0.9	0.9/1.0	37/25	25/20	20/15	1.2:1	120	1	**KBP-243**
19.5 ± 1.0	0.5 - 400	± 1.0	0.3/0.5	0.4/0.5	0.5/0.6	35/25	33/20	25/15	1.5:1	120	1	**KDP-243**

THROUGH HOLE (TO-5 & TO-8)

104



127

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
6.0 ± 0.5	10 - 100	± 0.25	1.5/2.0	1.5/2.0	1.5/2.0	30/25	30/25	30/25	1.2:1	104	2	**KAP-541**
6.0 ± 0.5	10 - 100	± 0.25	1.5/2.0	1.5/2.0	1.5/2.0	30/25	30/25	30/25	1.2:1	127	3	**KAP-841**
10.8 ± 1.0	10 - 500	± 0.7	0.6/1.0	0.8/1.2	0.8/1.6	30/25	25/20	25/17	1.3:1	104	2	**KBP-543**
10.8 ± 1.0	10 - 500	± 0.7	0.6/1.0	0.8/1.2	0.8/1.6	30/25	25/20	25/17	1.3:1	127	3	**KBP-843**
20.0 ± 1.0	10 - 500	± 0.5	0.3/0.5	0.4/0.5	0.5/0.6	35/28	35/25	30/17	1.4:1	104	2	**KDP-543**
20.0 ± 1.0	10 - 500	± 0.5	0.3/0.5	0.4/0.5	0.5/0.6	35/28	35/25	30/17	1.4:1	127	3	**KDP-843**

Power rating (all models) = 1 Watt, max
Impedance, unless otherwise noted is 50 ohms.
For pin location and package outline drawings, see back pages.

LB=LF to 10 LF
MB=10 LF to HF/2
UB=HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	FORWARD COUPLED	REVERSE COUPLED	CASE GND
#1	6	3	4	1	All Other
#2	8	5	11	2	All Other
#3	1	2	4	3	5

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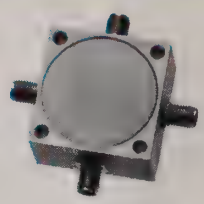
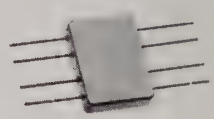
BI-DIRECTIONAL COUPLERS



COAXIAL CONNECTOR

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
6.0 ± 0.5	10 - 100	± 0.25	1.5/2.0	1.5/2.0	1.5/2.0	30/25	30/25	30/25	1.2:1	113	1	**KAK-741***
10.0 ± 1.0	2 - 100	± 0.5	0.9/1.0	0.9/1.0	0.9/1.0	45/35	37/33	35/30	1.2:1	113	1	**KBK-741***
10.8 ± 0.5	10 - 500	± 0.5	0.6/1.0	0.8/1.2	0.8/1.6	30/25	25/23	25/20	1.3:1	113	1	**KBK-743***
11.5 ± 0.5	10 - 1000	± 1.1	1.5/1.8	1.6/1.9	1.6/2.0	45/30	28/23	20/15	1.4:1	113	1	**KBK-744***
15.0 ± 1.0	2 - 100	± 0.5	0.4/0.5	0.3/0.5	0.4/0.6	35/30	35/30	33/30	1.3:1	113	1	**KCK-741***
15.0 ± 1.0	10 - 500	± 0.75	0.5/0.8	0.7/1.0	0.8/1.2	35/25	33/25	30/25	1.3:1	113	1	**KCK-743***
15.0 ± 1.0	5 - 1000	± 0.75	0.5/1.0	0.8/1.3	1.0/1.65	30/25	28/23	25/20	1.5:1	113	1	**KCK-744***
20.0 ± 1.0	2 - 100	± 0.5	.15/.25	0.1/0.2	0.1/.25	43/33	38/33	33/30	1.06:1	113	1	**KDK-741***
20.0 ± 1.0	10 - 500	± 0.5	0.3/0.6	0.4/0.8	0.5/1.0	35/28	35/25	35/25	1.3:1	113	1	**KDK-743***
20.0 ± 1.0	10 - 1000	± 1.0	0.1/0.2	0.3/1.0	1.0/1.5	30/23	25/18	20/15	1.3:1	113	1	**KDK-744***



FLAT-PACK

COUPLING (dB) NOM	FREQUENCY RANGE LF-HF (MHz)	COUPLING FLATNESS (dB)	MAINLINE LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	DIRECTIVITY (dB) LB TYP/MIN	MB TYP/MIN	UB TYP/MIN	VSWR TYP	PACKAGE	PIN-OUT (See Below)	MODEL
10.8 ± 0.7	10 - 500	± 0.5	1.0/1.3	1.0/1.4	1.2/1.6	28/23	28/24	23/20	1.2:1	101	2	**KBF-143**
20.3 ± 0.7	10 - 500	± 0.5	0.3/0.4	0.3/0.5	0.4/0.5	35/28	35/25	30/20	1.35:1	101	2	**KDF-143**

Power rating (all models) = 1 Watt, max
* Select connector suffix: "S" = SMA, "B" = BNC, "N" = Type N, "T" = TNC
Impedance, unless otherwise noted is 50 ohms.
For pin location and package outline drawings, see back pages.

LB=LF to 10 LF
MB=10 LF to HF/2
UB=HF/2 to HF

PIN-OUT TABLE

	INPUT	OUTPUT	FORWARD COUPLED	REVERSE COUPLED	CASE GND
#1	1	4	2	3	-
#2	1	5	4	8	All Other

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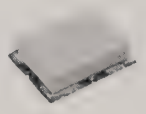
FREQUENCY DOUBLERS

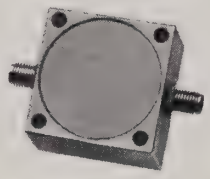
LEADED SURFACE-MOUNT MODELS

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 500	2 - 1000	+ 4	+ 10	13.5/16.5	25/15	40/25	159	1	SLX-K3
50 - 750	100 - 1500♦	+ 6	+ 15	10.5/13.5	25/15	35/20	159	1	SLX-K5
50 - 1250	150 - 2500♦	+ 6	+ 15	10.5/13.5	30/20	35/20	159	1	SLX-K7
75 - 1500	150 - 3000♦	+ 10	+ 16	12.0/14.0	25/17	25/17	159	1	SLX-K8



LEADEDLESS SURFACE-MOUNT MODELS

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
0.003 - 2.5	0.06 - 5	+ 4	+ 13	11.5/15.0	35/20	40/20	152	1	SMX-C1
0.005 - 25	0.01 - 50	+ 4	+ 13	11.5/15.0	35/20	40/20	152	1	SMX-C2
0.05 - 150	1 - 300	+ 4	+ 13	11.5/15.0	35/20	40/20	152	1	SMX-C3
1 - 500	2 - 1000	+ 4	+ 10	13.5/16.5	25/15	40/25	133	2	SMX-C4
50 - 750	100 - 1500♦	+ 6	+ 15	10.5/13.5	25/15	35/20	133	2	SMX-C5
50 - 1000	100 - 2000♦	+ 10	+ 20	12.5/16.0	30/12	35/16	133	2	SMX-C6
50 - 1250	100 - 2500♦	+ 6	+ 15	10.5/13.5	30/20	35/20	133	2	SMX-C7
75 - 1500	150 - 3000♦	+ 10	+ 16	12.0/14.0	25/17	25/17	133	2	SMX-C8
500 - 2000	1000 - 4000♦	+ 10	+ 16	12.0/17.0	15/10	20/15	133	2	SMX-C9



COAXIAL CONNECTOR MODELS

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
0.05 - 150	0.1 - 300	0	+ 13	11.5/15.0	35/20	40/20	118	3	XK-703*
1 - 500	2 - 1000	+ 1	+ 15	13.5/16.5	25/15	40/25	118	3	XK-702*
50 - 1250	100 - 2500♦	+ 4	+ 20	10.5/13.5	30/20	35/20	118	3	XK-701*

♦Specifications are for operation at +13 dBm (nominal) input power.
Nominal impedance is 50 ohms.
*Select female connector suffix: S=SMA, B=BNC, N=Type N, T=TNC
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	OUTPUT	GROUND	NO CONN.
# 1	1	4	2,3,5,6	—
# 2	1	2	4,5,6	3
# 3	1	2	—	—

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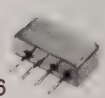
FREQUENCY DOUBLERS

THROUGH HOLE MOUNT 8 PIN - RELAY HEADER

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
0.003 - 2.5	0.006 - 5	0	+ 10	11.5/15.0	35/20	40/20	102	1	**XP-214**
0.005 - 25	0.01 - 50	0	+ 10	11.5/15.0	35/20	40/20	102	1	**XP-224**
0.05 - 150	0.1 - 300	0	+ 13	11.5/15.0	35/20	40/20	102	2	**XP-203**
1 - 500	2 - 1000	+ 1	+ 15	13.5/16.5	25/15	40/25	102	1	**XP-212**
50 - 750	100 - 1500◆	+ 4	+ 20	10.5/13.5	25/15	35/20	102	3	**XP-204**

MINI RELAY HEADER (4-pin and 8-pin)

103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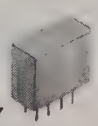

107

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
1 - 500	2 - 1000	+ 1	+ 15	13.5/16.5	25/15	40/25	107	1	**XP-402**
1 - 500	2 - 1000	+ 1	+ 15	13.5/16.5	25/15	40/25	106	4	**XP-322**
75 - 1500	150 - 3000◆	+ 10	+ 16	12.0/14.0	25/17	25/17	103	3	**XP-316**

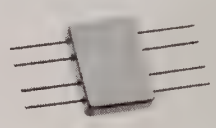
TO-8 and TO-5

122

126

FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
50 - 1000	100 - 2000◆	+ 4	+ 20	10.5/13.5	30/20	35/20	122	5	**XP-601**
50 - 1000	100 - 2000◆	+ 4	+ 20	10.5/13.5	30/20	35/20	126	5	**XP-801**

FLAT PACK



FREQUENCY RANGE (MHz) INPUT	OUTPUT	INPUT POWER (dBm) MIN	MAX	CONVERSION LOSS (dB) TYP/MAX	SPURIOUS (dB) F1 TYP/MIN	F3 TYP/MIN	PACKAGE	PIN-OUT (See Below)	MODEL
50 - 1250	100 - 2500◆	+ 4	+ 20	10.5/13.5	30/18	35/20	101	6	**XF-111**

* Pins must be connected together externally

◆Specifications are for operation at +13 dBm (nominal) input power.

Nominal impedance is 50 ohms.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	INPUT	OUTPUT	GROUND	CASE GROUND
# 1	*1,3,4	8	2,5,6,7	2,5,6,7
# 2	*1,3,4	8	2,5,6,7	2
# 3	1	8	All Other	All Other
# 4	*1,2	4	3	3
# 5	1	3	2,4	2,4
# 6	5	4	All Other	All Other

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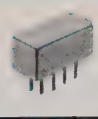
SYNERGY® MICROWAVE CORPORATION

FIXED ATTENUATORS

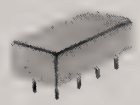
8-PIN MINI - RELAY HEADER



FREQUENCY RANGE (MHz)	ATTENUATION (dB) NOM.	FLATNESS (dB), MAX.			VSWR MAX.			PACKAGE	PIN-OUT (See Below)	MODEL
		LB	MB	UB	LB	MB	UB			
DC-1500	3 ± 0.2	0.3	0.6	1.0	1.3	1.5	1.7	108	1	AFP-403
DC-1500	6 ± 0.3	0.3	0.6	1.0	1.3	1.5	1.7	108	1	AFP-406
DC-1500	10 ± 0.4	0.3	0.6	1.0	1.3	1.5	1.7	108	1	AFP-410
DC-1500	15 ± 0.4	0.4	0.7	1.1	1.3	1.5	1.7	108	1	AFP-415
DC-1500	20 ± 0.5	0.4	0.8	1.3	1.3	1.6	1.8	108	1	AFP-420
DC-1000	30 ± 0.5	0.5	1.0	-	1.3	1.6	-	108	1	AFP-430
DC-500	40 ± 0.6	1.0	-	-	1.5	-	-	108	1	AFP-440

NOTE: Maximum RF power is 1/2 Watt.

8-PIN - RELAY HEADER



FREQUENCY RANGE (MHz)	ATTENUATION (dB) NOM.	FLATNESS (dB), MAX.			VSWR MAX.			PACKAGE	PIN-OUT (See Below)	MODEL
		LB	MB	UB	LB	MB	UB			
DC-1500	3 ± 0.2	0.3	0.6	1.0	1.3	1.5	1.7	103	1	AFP-203
DC-1500	6 ± 0.3	0.3	0.6	1.0	1.3	1.5	1.7	103	1	AFP-206
DC-1500	10 ± 0.4	0.3	0.6	1.0	1.3	1.5	1.7	103	1	AFP-210
DC-1500	15 ± 0.4	0.4	0.7	1.1	1.3	1.5	1.7	103	1	AFP-215
DC-1500	20 ± 0.5	0.4	0.8	1.3	1.3	1.6	1.8	103	1	AFP-220
DC-1000	30 ± 0.5	0.5	1.0	-	1.3	1.6	-	103	1	AFP-230
DC-500	40 ± 0.6	1.0	-	-	1.5	-	-	103	1	AFP-240

NOTE: Maximum RF power is 1/2 Watt.

LB=LOW (DC-500 MHz)
MB=MID (DC-1000 MHz)
UB=UPPER (DC-1500 MHz)

PIN-OUT TABLE

	INPUT	OUTPUT	GROUND
# 1	1	8	2,3,4,5,6,7

For pin location and package outline drawings, see back pages.

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SYNERGY® MICROWAVE CORPORATION

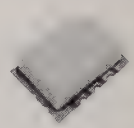
TRANSFORMERS

LEADLESS SURFACE-MOUNT MODELS

IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:1	No	Yes	.003-300	.02-50	.01-150	.003-300	1	134	1	**ST-K1**
1:1.5	No	No	.075-400	.370-185	.120-300	.075-400	2	134	2	**ST-K2**
1:2	No	No	.650-525	-	2.2-400	.650-525	2	134	2	**ST-K3**
1:2.5	No	Yes	.070-300	.780-175	.140-225	.070-300	1	134	1	**ST-K4**
1:3	No	No	.270-500	3.6-160	.490-430	.270-500	2	134	2	**ST-K5**
1:4	No	Yes	.2-350	2-100	.35-300	.2-350	1	134	1	**ST-K6**
1:5	No	Yes	.3-300	.5-100	.6-200	.3-300	1	134	1	**ST-K7**
1:6	No	No	.3-200	5-50	.5-150	.3-200	2	134	2	**ST-K8**

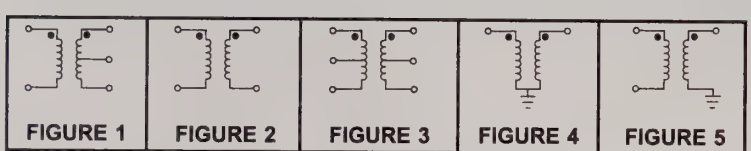
NOTE: All devices shown have 1 Watt Power Rating
Temperature range for plastic package is -25°C to +85°C

LEADLESS SURFACE-MOUNT MODELS



IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	INSERTION LOSS (dB),MAX	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:4	No	Yes	60-250	1.5	1	129	1	**SMT-C1**
1:4	No	Yes	350-600	2.5	1	129	1	**SMT-C2**
1:16	No	Yes	60-250	3.5	1	129	1	**SMT-C3**
1:16	No	Yes	350-600	5.5	1	129	1	**SMT-C4**

NOTE: All devices shown have 1 Watt Power Rating
Temperature range for plastic package is -25°C to +85°C



For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	Primary DOT	Primary	Primary Center-Tap	Secondary DOT	Secondary	Secondary Center-Tap
# 1	4	6	-	3	1	2
# 2	4	6	-	3	1	-

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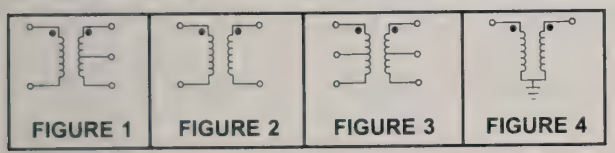
TRANSFORMERS

LEADED SURFACE-MOUNT MODELS

IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:1	No	Yes	.04-140	.100-55	.05-100	.04-140	1	156	1	TW-207
1:1	No	Yes	.05-200	.2-80	.08-150	.05-200	1	156	1	TW-2Q2
1:1	No	Yes	.003-300	.02-50	.01-150	.003-300	1	156	1	TW-2A2
1:1	No	Yes	5-450	12-150	7-300	5-450	1	156	1	TW-206
1:1	No	No	.028-1000	.055-450	.035-900	.028-1000	2	156	2	TW-205
1:1	No	No	9.0-1200	20-150	12-790	9.0-1200	2	156	2	TW-204
1:1.5	No	Yes	.480-175	2-54	.135-120	.480-175	1	156	1	TW-209
1:1.5	No	No	.075-400	.370-185	.120-300	.075-400	2	156	2	TW-208
1:1.5	No	No	.100-400	.250-200	.140-300	.100-400	2	156	2	TW-211
1:1.5	Yes	Yes	.075-500	1.0-50	.2-100	.075-500	3	156	3	TW-2A3
1:2	No	Yes	.060-250	1.7-55	.100-190	.060-250	1	156	1	TW-216
1:2	No	No	.100-275	1.0-85	.200-195	.100-275	2	156	2	TW-215
1:2	No	No	.650-525	-	2.2-400	.650-525	2	156	2	TW-210
1:2	No	No	.050-600	.5-200	.1-400	.050-600	4	156	4	TW-2A4
1:2.5	No	Yes	.01-100	.50-20	.02-50	.01-100	1	156	1	TW-2A1
1:2.5	No	Yes	.070-300	.780-175	.140-225	.070-300	1	156	1	TW-219
1:2.5	No	Yes	.300-300	-	.700-200	.300-300	1	156	1	TW-218
1:2.5	No	No	.230-495	4.8-175	.400-425	.230-495	2	156	2	TW-217
1:3	No	Yes	.05-250	.5-70	.1-200	.05-250	1	156	1	TW-2B2
1:3	No	Yes	.080-340	.550-150	.160-295	.080-340	1	156	1	TW-220
1:3	No	No	.270-500	3.6-160	.490-430	.270-500	2	156	2	TW-225
1:4	No	No	.02-200	.1-100	.05-150	.02-200	2	156	2	TW-2C2
1:4	No	No	.115-200	12.0-50	.240-155	.115-200	2	156	2	TW-227
1:4	No	Yes	.245-425	5.5-215	.475-350	.245-425	1	156	1	TW-226
1:4	No	Yes	.2-350	2-100	.35-300	.2-350	1	156	1	TW-2C3
1:5	No	Yes	.3-300	.5-100	.6-200	.3-300	1	156	1	TW-2E2
1:8	No	No	.15-250	2-100	.25-200	.15-250	4	156	4	TW-2G2
1:9	No	No	.15-200	2.0-40	.3-150	.15-200	2	156	2	TW-2D2
1:13	No	Yes	.3-120	5.0-20	.7-80	.3-120	1	156	1	TW-2F2
1:16	No	No	.3-120	5.0-20	.7-80	.3-120	2	156	2	TW-2H2
1:36	No	No	.03-20	.1-5.0	.05-10	.03-20	2	156	2	TW-2B1
1:4	No	Yes	.02-250	.1-100	.05-150	.02-250	1	156	1	TW-2K1

NOTE: All devices shown have 1 Watt Power Rating
Temperature range for plastic package is -25°C to +85°C



For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	Primary DOT	Primary	Primary Center-Tap	Secondary DOT	Secondary	Secondary Center-Tap
# 1	4	6	-	3	1	2
# 2	4	6	-	3	1	-
# 3	4	6	5	3	1	2
# 4	6	*3	-	1	*3	-

* Pin must be grounded

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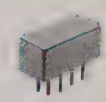
Miniature 8 Pin - Relay Header



IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:1	No	Yes	.04-140	.100-55	.05-100	.04-140	1	108	2	**TP-207**
1:1	No	Yes	5-450	12-150	7-300	5-450	1	108	2	**TP-206**
1:1	No	No	1-800	-	2-500	1-800	2	108	4	**TP-2C4**
1:1	No	No	.028-1000	.055-450	.035-900	.028-1 000	2	108	3	**TP-205**
1:1	No	No	9.0-1200	20-150	12-790	9.0-1200	2	108	3	**TP-204**
1:1.5	No	Yes	.480-175	2-54	.135-120	.480-175	1	108	2	**TP-209**
1:1.5	No	No	.1-300	.5-8	.2-150	.1-300	2	108	3	**TP-2R2**
1:1.5	No	No	.075-400	.370-1 85	.1 20-300	.075-400	2	108	3	**TP-208**
1:1.5	No	No	.100-400	.250-200	.140-300	.100-400	2	108	3	**TP-211**
1:2	No	Yes	.07-200	0.5-50	.1-100	.07-200	1	108	2	**TP-2J2**
1:2	No	Yes	.060-250	1.7-55	.100-190	.060-250	1	108	2	**TP-216**
1:2	No	No	.100-275	1.0-85	.200-195	.100-275	2	108	3	**TP-215**
1:2	No	No	.650-525	-	2.2-400	.650-525	2	108	3	**TP-210**
1:2	No	No	.050-600	.5-200	.1-400	.060-600	4	108	1	**TP-2B4**
1:2.5	No	Yes	.070-300	.780-175	.140-225	.070-300	1	108	2	**TP-219**
1:2.5	No	Yes	.300-300	-	.700-200	.300-300	1	108	2	**TP-218**
1:2.5	No	No	.230-495	4.8-175	.400-425	.230-495	2	108	3	**TP-217**
1:3	No	Yes	.080-340	.550-150	.1 60-295	.080-340	1	108	2	**TP-220**
1:3	No	No	.270-500	3.6-160	.490-430	.270-500	2	108	3	**TP-225**
1:4	No	No	115-200	12.0-50	.240-155	.115-200	2	108	3	**TP-227**
1:4	No	Yes	.2-350	2-100	.35-300	.2-350	1	108	2	**TP-2D3**
1:4	No	Yes	.245-425	5.5-215	.475-350	245-425	1	108	2	**TP-226**
1:5	No	Yes	.3-300	5-100	.6-200	3-300	1	108	2	**TP-2M2**
1:6	No	No	.3-200	.3-200	.5-150	5-50	2	108	3	**TP-2T2**
1:8	No	No	.15-250	2-100	.25-200	.15-250	4	108	1	**TP-2L2**
1:9	No	No	.15-200	2.0-40	.3-150	.15-200	2	108	3	**TP-2N2**
1:16	No	No	.3-120	5.0-20	.7-80	.3-120	2	108	3	**TP-2P2**

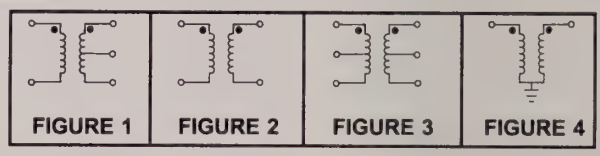
NOTE: All devices shown have 1 Watt Power Rating

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	Primary DOT	Primary	Primary Center-Tap	Secondary DOT	Secondary	Secondary Center-Tap	Case Ground
#1	1	*6	-	2	*6	-	7,8
#2	1	5	-	2	6	4	7,8
#3	1	5	-	2	6	-	7,8
#4	1	3	-	2	4	-	7,8

* Pin must be grounded



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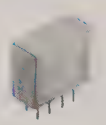
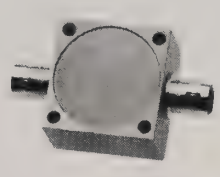


8 PIN - MINIATURE RELAY HEADER

IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:2.5	No	Yes	.01-100	.05-20	.02-50	.01-100	1	107	1	**TP-2C1**
1:4	No	No	.02-200	.1-100	.05-150	.02-200	2	107	2	**TP-2K2**

NOTE: All devices shown have 1 Watt Power Rating



CONNECTORIZED PACKAGE

IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:1.5	No	No	0.1-400	5-100	1-200	0.1-400	4	118	4	**TK-701B**
1:1	No	No	0.01-125	0.1-25	0.05-50	0.01-125	5	118	3	**TK-702B**
1:1	No	No	0.2-500	1-100	0.5-300	0.2-500	5	118	3	**TK-703B**

NOTE: All devices shown have 1 Watt Power Rating

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	Primary DOT	Primary	Primary Center-Tap	Secondary DOT	Secondary	Secondary Center-Tap	Case Ground
# 1	1	5	-	2	6	4	7,8
# 2	1	5	-	2	6	-	7,8
# 3	-	Balanced	-	-	Unbalanced	-	-
# 4	1	*6	-	2	*6	-	7,8

* Pin must be grounded

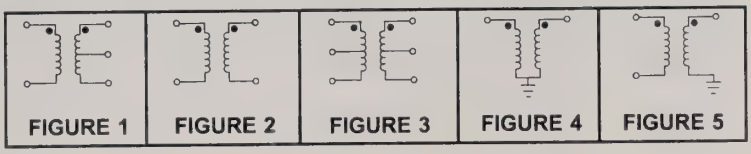


FIGURE 1 | FIGURE 2 | FIGURE 3 | FIGURE 4 | FIGURE 5

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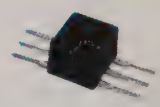
TRANSFORMERS

PLASTIC FLAT-PACK MODELS



IMPEDANCE RATIO PRI : SEC	CENTER TAP PRI	CENTER TAP SEC	FREQUENCY (MHz)	BANDWIDTH (MHz) for INSERTION-LOSS 1dB	2dB	3dB	FIGURE (See Below)	PACKAGE	PIN-OUT (See Below)	MODEL
1:1	No	Yes	.04-140	.100-55	.05-100	.04-140	1	116	1	**TX-207**
1:1	No	Yes	.05-200	.2-80	.08-150	.05-200	1	116	1	**TX-202**
1:1	No	Yes	.003-300	.02-50	.01-150	.003-300	1	116	1	**TX-2A2**
1:1	No	Yes	5-450	12-150	7-300	5-450	1	116	1	**TX-206**
1:1	No	No	.028-1000	.055-450	.035-900	.028-1000	2	116	4	**TX-205**
1:1	No	No	9.0-1200	20-150	12-790	9.0-1200	2	116	4	**TX-204**
1:1.5	No	Yes	.480-175	2-54	.135-120	.480-175	1	116	1	**TX-209**
1:1.5	No	No	.075-400	.370-185	.120-300	.075-400	2	116	4	**TX-208**
1:1.5	No	No	.100-400	.250-200	.140-300	.100-400	2	116	4	**TX-211**
1:1.5	Yes	Yes	.075-500	1.0-50	.2-100	.075-500	3	116	3	**TX-2A3**
1:2	No	Yes	.060-250	1.7-55	.100-190	.060-250	1	116	1	**TX-216**
1:2	No	No	.100-275	1.0-85	.200-195	.100-275	2	116	4	**TX-215**
1:2	No	No	.650-525	-	2.2-400	.650-525	2	116	4	**TX-210**
1:2	No	No	.050-600	.5-200	.1-400	.050-600	4	116	2	**TX-2A4**
1:2.5	No	Yes	.01-100	.50-20	.02-50	.01-100	1	116	1	**TX-2A1**
1:2.5	No	Yes	.070-300	.780-175	.140-225	.070-300	1	116	1	**TX-219**
1:2.5	No	Yes	.300-300	-	.700-200	.300-300	1	116	1	**TX-218**
1:2.5	No	No	.230-495	4.8-175	.400-425	.230-495	2	116	4	**TX-217**
1:3	No	Yes	.05-250	.5-70	.1-200	.05-250	1	116	1	**TX-2B2**
1:3	No	Yes	.080-340	.550-1 50	.160-295	.080-340	1	116	1	**TX-220**
1:3	No	No	.270-500	3.6-160	.490-430	.270-500	2	116	4	**TX-225**
1:4	No	No	.02-200	.1-100	.05-150	.02-200	2	116	4	**TX-2C2**
1:4	No	No	.115-200	12.0-50	.240-1 55	.115-200	2	116	4	**TX-227**
1:4	No	Yes	.245-425	5.5-215	.475-350	.245-425	1	116	1	**TX-226**
1:4	No	Yes	.2-350	2-100	.35-300	.2-350	1	116	1	**TX-2C3**
1:5	No	Yes	.3-300	.5-100	.6-200	.3-300	1	116	1	**TX-2E2**
1:8	No	No	.15-250	2-100	.25-200	.15-250	4	116	2	**TX-2G2**
1:9	No	No	.15-200	2.0-40	.3-150	.15-200	2	116	4	**TX-2D2**
1:1 3	No	Yes	.3-120	5.0-20	.7-80	.3-120	1	116	1	**TX-2F2**
1:1 6	No	No	.3-120	5.0-20	.7-80	.3-120	2	116	4	**TX-2H2**
1:36	No	No	.03-20	.1-5.0	.05-10	.03-20	2	116	4	**TX-2B1**

NOTE: All devices shown have 1 Watt Power Rating
Temperature range for plastic package is -25°C to +85°C

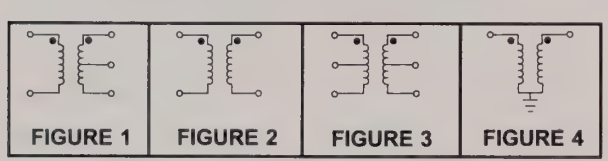


FIGURE 1 | FIGURE 2 | FIGURE 3 | FIGURE 4

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

	Primary DOT	Primary	Primary Center-Tap	Secondary DOT	Secondary	Secondary Center-Tap
# 1	4	6	-	3	1	2
# 2	6	*3	-	1	*3	-
# 3	4	6	5	3	1	2
# 4	4	6	-	3	1	-

* Pin must be grounded

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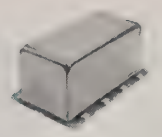
LOW PASS

Leadless Surface-Mount Models
Low Cost



Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 1 dB (MHz)	STOP BAND FREQUENCY (MHz) >35 dB	>23 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
12	DC-10.7	21	19	16	1.70:1	102S	1	**FLS-12**
24	DC-21.4	42	37	32	1.70:1	102S	1	**FLS-24**
33	DC-30	58	51	44	1.70:1	102S	1	**FLS-33**
55	DC-50	96	85	74	1.70:1	102S	1	**FLS-55**
66	DC-60	115	102	89	1.70:1	102S	1	**FLS-66**
77	DC-70	135	120	103	1.70:1	102S	1	**FLS-77**
100	DC-92	175	155	133	1.70:1	102S	1	**FLS-100**
154	DC-140	270	235	208	1.70:1	102S	1	**FLS-154**
220	DC-200	385	340	300	1.70:1	102S	1	**FLS-220**
330	DC-300	575	510	445	1.70:1	102S	1	**FLS-330**
495	DC-450	865	765	665	1.70:1	102S	1	**FLS-495**
570	DC-520	995	880	765	1.70:1	102S	1	**FLS-570**
660	DC-600	1160	1020	890	1.70:1	102S	1	**FLS-660**
770	DC-700	1345	1185	1000	1.70:1	102S	1	**FLS-770**
825	DC-750	1445	1360	1275	1.70:1	102S	1	**FLS-825**
850	DC-780	1485	1315	1130	1.70:1	102S	1	**FLS-850**
965	DC-875	1690	1595	1495	1.70:1	102S	1	**FLS-965**
1100	DC-1000	1925	1815	1700	1.70:1	102S	1	**FLS-1100**

NOTE: All units meet or exceed applicable MIL-F-18327.

For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	8	All Other

For pin location and package outline drawings, see back pages.

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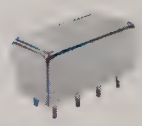
FILTERS
LOW PASS

8 PIN - RELAY HEADER
LOW COST



Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 1 dB (MHz)	STOP BAND FREQUENCY (MHz) >35 dB	>23 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
12	DC-10.7	21	19	16	1.70:1	102	1	**FLP-12**
24	DC-21.4	42	37	32	1.70:1	102	1	**FLP-24**
33	DC-30	58	51	44	1.70:1	102	1	**FLP-33**
55	DC-50	96	85	74	1.70:1	102	1	**FLP-55**
66	DC-60	115	102	89	1.70:1	102	1	**FLP-66**
77	DC-70	135	120	103	1.70:1	102	1	**FLP-77**
100	DC-92	175	155	133	1.70:1	102	1	**FLP-100**
154	DC-140	270	235	208	1.70:1	102	1	**FLP-154**
220	DC-200	385	340	300	1.70:1	102	1	**FLP-220**
330	DC-300	575	510	445	1.70:1	102	1	**FLP-330**
495	DC-450	865	765	665	1.70:1	102	1	**FLP-495**
570	DC-520	995	880	765	1.70:1	102	1	**FLP-570**
660	DC-600	1160	1020	890	1.70:1	102	1	**FLP-660**
770	DC-700	1345	1185	1000	1.70:1	102	1	**FLP-770**
825	DC-750	1445	1360	1275	1.70:1	102	1	**FLP-825**
850	DC-780	1485	1315	1130	1.70:1	102	1	**FLP-850**
965	DC-875	1690	1595	1495	1.70:1	102	1	**FLP-965**
1100	DC-1000	1925	1815	1700	1.70:1	102	1	**FLP-1100**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	8	All Other

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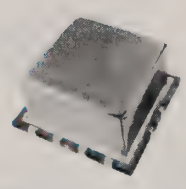
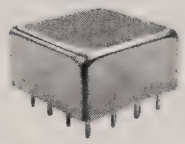
Leadless Surface-Mount Models
High Suppression



Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 2 dB (MHz)	STOP BAND FREQUENCY (MHz) >50 dB	>30 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
12	DC-10.7	21	19	16	1.70:1	124S	1	**FLHS-12**
24	DC-21.4	42	37	32	1.70:1	124S	1	**FLHS-24**
33	DC-30	58	51	44	1.70:1	124S	1	**FLHS-33**
55	DC-50	96	85	74	1.70:1	124S	1	**FLHS-55**
66	DC-60	115	102	89	1.70:1	124S	1	**FLHS-66**
77	DC-70	135	120	103	1.70:1	124S	1	**FLHS-77**
154	DC-140	270	235	208	1.70:1	124S	1	**FLHS-154**
220	DC-200	385	340	300	1.70:1	124S	1	**FLHS-220**
330	DC-300	575	510	445	1.70:1	124S	1	**FLHS-330**
495	DC-450	865	765	665	1.70:1	124S	1	**FLHS-495**
660	DC-600	1160	1020	890	1.70:1	124S	1	**FLHS-660**
825	DC-750	1445	1360	1275	1.70:1	124S	1	**FLHS-825**
965	DC-875	1690	1595	1495	1.70:1	124S	1	**FLHS-965**
1100	DC-1000	1925	1815	1700	1.70:1	124S	1	**FLHS-1100**

24 Pin - Through Hole Mount
High Suppression



Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 2 dB (MHz)	STOP BAND FREQUENCY (MHz) >50 dB	>30 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
12	DC-10.7	21	19	16	1.70:1	124	1	**FLH-12**
24	DC-21.4	42	37	32	1.70:1	124	1	**FLH-24**
33	DC-30	58	51	44	1.70:1	124	1	**FLH-33**
55	DC-50	96	85	74	1.70:1	124	1	**FLH-55**
66	DC-60	115	102	89	1.70:1	124	1	**FLH-66**
77	DC-70	135	120	103	1.70:1	124	1	**FLH-77**
154	DC-140	270	235	208	1.70:1	124	1	**FLH-154**
220	DC-200	385	340	300	1.70:1	124	1	**FLH-220**
330	DC-300	575	510	445	1.70:1	124	1	**FLH-330**
495	DC-450	865	765	665	1.70:1	124	1	**FLH-495**
660	DC-600	1160	1020	890	1.70:1	124	1	**FLH-660**
825	DC-750	1445	1360	1275	1.70:1	124	1	**FLH-825**
965	DC-875	1690	1595	1495	1.70:1	124	1	**FLH-965**
1100	DC-1000	1925	1815	1700	1.70:1	124	1	**FLH-1100**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	16	All Other

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Leadless Surface-Mount Models
Low Cost

Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 1 dB (MHz)	STOP BAND FREQUENCY (MHz) >35 dB	>23 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
10	10.7-50	5	6	7	1.70:1	102S	1	**FHS-10**
20	21.4-100	10	13	15	1.70:1	102S	1	**FHS-20**
27	30-150	14	17	20	1.70:1	102S	1	**FHS-27**
45	50-250	23	29	34	1.70:1	102S	1	**FHS-45**
55	60-300	28	35	41	1.70:1	102S	1	**FHS-55**
64	70-300	32	40	48	1.70:1	102S	1	**FHS-64**
127	140-630	65	80	95	1.70:1	102S	1	**FHS-127**
182	200-850	90	110	135	1.70:1	102S	1	**FHS-182**
270	300-1200	135	170	200	1.70:1	102S	1	**FHS-270**
410	450-1400	205	255	305	1.70:1	102S	1	**FHS-410**
545	600-1600	225	320	410	1.70:1	102S	1	**FHS-545**
680	750-1900	340	425	510	1.70:1	102S	1	**FHS-680**
795	875-2000	400	500	600	1.70:1	102S	1	**FHS-795**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	8	All Other

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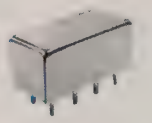
8 PIN - RELAY HEADER
LOW COST



Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 1 dB (MHz)	STOP BAND FREQUENCY (MHz) >35 dB	>23 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
10	10.7-50	5	6	7	1.70:1	102	1	**FHP-10**
20	21.4-100	10	13	15	1.70:1	102	1	**FHP-20**
27	30-150	14	17	20	1.70:1	102	1	**FHP-27**
45	50-250	23	29	34	1.70:1	102	1	**FHP-45**
55	60-300	28	35	41	1.70:1	102	1	**FHP-55**
64	70-300	32	40	48	1.70:1	102	1	**FHP-64**
127	140-630	65	80	95	1.70:1	102	1	**FHP-127**
182	200-850	90	110	135	1.70:1	102	1	**FHP-182**
270	300-1200	135	170	200	1.70:1	102	1	**FHP-270**
410	450-1400	205	255	305	1.70:1	102	1	**FHP-410**
545	600-1600	225	320	410	1.70:1	102	1	**FHP-545**
680	750-1900	340	425	510	1.70:1	102	1	**FHP-680**
795	875-2000	400	500	600	1.70:1	102	1	**FHP-795**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	8	All Other

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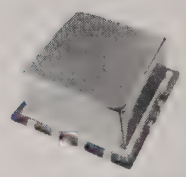
FILTERS

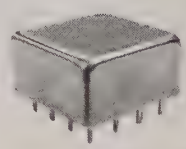
HIGH PASS

HIGH SUPPRESSION



Leadless Surface-Mount Models

Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 2 dB (MHz)	STOP BAND FREQUENCY (MHz) >50 dB	>30 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
10	10.7-50	5	6	7	1.70:1	124S	1	**FHHS-10**
20	21.4-100	10	12	14	1.70:1	124S	1	**FHHS-20**
27	30-150	14	17	20	1.70:1	124S	1	**FHHS-27**
45	50-250	23	29	34	1.70:1	124S	1	**FHHS-45**
55	60-300	28	35	41	1.70:1	124S	1	**FHHS-55**
64	70-300	32	40	48	1.70:1	124S	1	**FHHS-64**
127	140-630	65	80	95	1.70:1	124S	1	**FHHS-127**
182	200-850	90	110	135	1.70:1	124S	1	**FHHS-182**
270	300-1200	135	170	200	1.70:1	124S	1	**FHHS-270**
410	450-1400	205	255	305	1.70:1	124S	1	**FHHS-410**
545	600-1600	225	320	410	1.70:1	124S	1	**FHHS-545**
680	750-1900	340	425	510	1.70:1	124S	1	**FHHS-680**
795	875-2000	400	500	600	1.70:1	124S	1	**FHHS-795**



24 Pin - Through Hole Mount

Fc (MHz) LOSS = 3 dB (Nom)	PASSBAND LOSS < 2 dB (MHz)	STOP BAND FREQUENCY (MHz) >50 dB	>30 dB	>20 dB	PASS BAND V SWR (TYP)	PACKAGE	PIN-OUT (See Below)	MODEL
10	10.7-50	5	6	7	1.70:1	124	1	**FHH-10**
20	21.4-100	10	12	14	1.70:1	124	1	**FHH-20**
27	30-150	14	17	20	1.70:1	124	1	**FHH-27**
45	50-250	23	29	34	1.70:1	124	1	**FHH-45**
55	60-300	28	35	41	1.70:1	124	1	**FHH-55**
64	70-300	32	40	48	1.70:1	124	1	**FHH-64**
127	140-630	65	80	95	1.70:1	124	1	**FHH-127**
182	200-850	90	110	135	1.70:1	124	1	**FHH-182**
270	300-1200	135	170	200	1.70:1	124	1	**FHH-270**
410	450-1400	205	255	305	1.70:1	124	1	**FHH-410**
545	600-1600	225	320	410	1.70:1	124	1	**FHH-545**
680	750-1900	340	425	510	1.70:1	124	1	**FHH-680**
795	875-2000	400	500	600	1.70:1	124	1	**FHH-795**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.
For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	16	All Other

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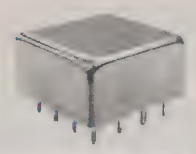
FILTERS
BANDPASS

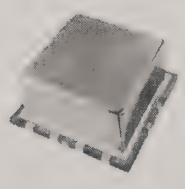
24 Pin - Through Hole Mount
High Suppression



Fc (MHz)	LOSS (dB)	1 dB RIPPLE BW (MHz)	20 dB BW (MHz)	40 dB BW (MHz) (50dB on low end)	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	3.5	0.5	9.63-11.8	8.5-12.85	124	1	**FBP-11**
21.4	3.5	1.0	19.26-23.6	17-25.70	124	1	**FBP-21**
30.0	3.5	1.5	27-33	24-36	124	1	**FBP-30**
45.0	3.5	2.2	40-50	35-56	124	1	**FBP-45**
50.0	4.0	2.5	45-56	40-62	124	1	**FBP-50**
60.0	4.0	3.0	54-67	48-74	124	1	**FBP-60**
70.0	4.6	3.5	63-77	56-86	124	1	**FBP-70**
140	5.0	8.0	125-160	110-175	124	1	**FBP-140**
200	6.0	12.0	180-230	155-250	124	1	**FBP-200**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies, please contact Synergy directly.

Leadless Surface-Mount Models
High Suppression



Fc (MHz)	LOSS (dB)	1 dB RIPPLE BW (MHz)	20 dB BW (MHz)	40 dB BW (MHz) (50dB on low end)	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	3.5	0.5	9.63-11.8	8.5-12.85	124S	1	**FBS-11**
21.4	3.5	1.0	19.26-23.6	17-25.70	124S	1	**FBS-21**
30.0	3.5	1.5	27-33	24-36	124S	1	**FBS-30**
45.0	3.5	2.2	40-50	35-56	124S	1	**FBS-45**
50.0	4.0	2.5	45-56	40-62	124S	1	**FBS-50**
60.0	4.0	3.0	54-67	48-74	124S	1	**FBS-60**
70.0	4.6	3.5	63-77	56-86	124S	1	**FBS-70**
140	5.0	8.0	125-160	110-175	124S	1	**FBS-140**
200	6.0	12.0	180-230	155-250	124S	1	**FBS-200**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
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For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	16	All Other

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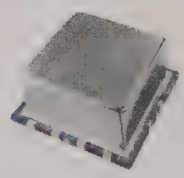
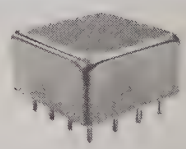


LEADLESS SURFACE-MOUNT MODELS

CENTER FREQUENCY (MHz)	INSERTION LOSS (dB) Max	PASSBAND (MHz)	35 dB BANDWIDTH (MHz)	VSWR	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	1.7	10.2 - 11.2	5.1 - 22.5	1.5:1	124S	1	FNS-10.7
21.4	1.7	20.3 - 22.5	10.2 - 45.0	1.5:1	124S	1	FNS-21.4
30.0	1.7	28.5 - 31.5	14.3 - 63.0	1.5:1	124S	1	FNS-30
45.0	1.7	42.8 - 47.3	21.3 - 94.5	1.5:1	124S	1	FNS-45
50.0	1.7	47.5 - 52.5	23.8 - 105	1.5:1	124S	1	FNS-50
60.0	1.7	57.0 - 63.0	28.4 - 126	1.5:1	124S	1	FNS-60
70.0	1.7	66.5 - 73.5	33.3 - 147	1.5:1	124S	1	FNS-70
100	2.7	95.0 - 105	47.5 - 210	1.5:1	124S	1	FNS-100
120	2.7	114 - 126	57.0 - 252	1.5:1	124S	1	FNS-120
140	2.7	133 - 147	66.5 - 294	1.5:1	124S	1	FNS-140
160	2.7	152 - 168	76.0 - 336	1.5:1	124S	1	FNS-160
180	2.7	171 - 189	85.5 - 378	1.5:1	124S	1	FNS-180
200	2.7	190 - 210	95 - 420	1.5:1	124S	1	FNS-200
250	3.0	238 - 262.5	119 - 525	1.5:1	124S	1	FNS-250
300	3.0	285.7 - 315	142.8 - 630	1.5:1	124S	1	FNS-300
350	3.0	333.3 - 367.5	166.7 - 735	1.5:1	124S	1	FNS-350
400	3.0	380.9 - 420	190.5 - 840	1.5:1	124S	1	FNS-400
450	3.0	428.6 - 472.5	214.3 - 945	1.5:1	124S	1	FNS-450
500	3.0	476.2 - 525	238.1 - 1050	1.5:1	124S	1	FNS-500



24 PIN - THROUGH HOLE MOUNT

CENTER FREQUENCY (MHz)	INSERTION LOSS (dB) Max	PASSBAND (MHz)	35 dB BANDWIDTH (MHz)	VSWR	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	1.7	10.2 - 11.2	5.1 - 22.5	1.5:1	124	1	FNP-10.7
21.4	1.7	20.3 - 22.5	10.2 - 45.0	1.5:1	124	1	FNP-21.4
30.0	1.7	28.5 - 31.5	14.3 - 63.0	1.5:1	124	1	FNP-30
45.0	1.7	42.8 - 47.3	21.3 - 94.5	1.5:1	124	1	FNP-45
50.0	1.7	47.5 - 52.5	23.8 - 105	1.5:1	124	1	FNP-50
60.0	1.7	57.0 - 63.0	28.4 - 126	1.5:1	124	1	FNP-60
70.0	1.7	66.5 - 73.5	33.3 - 147	1.5:1	124	1	FNP-70
100	2.7	95.0 - 105	47.5 - 210	1.5:1	124	1	FNP-100
120	2.7	114 - 126	57.0 - 252	1.5:1	124	1	FNP-120
140	2.7	133 - 147	66.5 - 294	1.5:1	124	1	FNP-140
160	2.7	152 - 168	76.0 - 336	1.5:1	124	1	FNP-160
180	2.7	171 - 189	85.5 - 378	1.5:1	124	1	FNP-180
200	2.7	190 - 210	95 - 420	1.5:1	124	1	FNP-200

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	16	All Other

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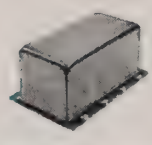
FILTERS
BANDPASS



Leadless Surface-Mount Models

CENTER FREQUENCY (MHz)	INSERTION LOSS (dB) Max	PASSBAND (MHz)	20 dB BANDWIDTH (MHz)	40 dB BANDWIDTH (MHz)	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	1.5	9.80 - 11.6	7.49 - 13.9	3.40 - 32.1	102S	1	**FIS-10.7**
21.4	1.5	19.6 - 23.2	14.9 - 27.8	6.80 - 64.2	102S	1	**FIS-21.4**
30.0	1.5	27.5 - 32.5	21.0 - 39.0	9.30 - 90.0	102S	1	**FIS-30**
45.0	1.5	41.2 - 48.8	31.5 - 58.5	13.0 - 135	102S	1	**FIS-45**
50.0	1.5	45.8 - 54.3	35.0 - 65.0	15.8 - 150	102S	1	**FIS-50**
60.0	1.5	54.9 - 65.1	42.0 - 78.0	19.0 - 180	102S	1	**FIS-60**
70.0	1.5	64.0 - 75.9	49.0 - 91.0	20.3 - 210	102S	1	**FIS-70**
100	1.5	91.5 - 108.5	70.0 - 130	30.3 - 300	102S	1	**FIS-100**
120	1.5	109.8 - 130.2	84.0 - 156	36.0 - 360	102S	1	**FIS-120**
140	1.5	128.1 - 151.9	98.0 - 182	42.7 - 420	102S	1	**FIS-140**

8 Pin - Relay Header

CENTER FREQUENCY (MHz)	INSERTION LOSS (dB) Max	PASSBAND (MHz)	20 dB BANDWIDTH (MHz)	40 dB BANDWIDTH (MHz)	PACKAGE	PIN-OUT (See Below)	MODEL
10.7	1.5	9.80 - 11.6	7.49 - 13.9	3.40 - 32.1	102	1	**FIP-10.7**
21.4	1.5	19.6 - 23.2	14.9 - 27.8	6.80 - 64.2	102	1	**FIP-21.4**
30.0	1.5	27.5 - 32.5	21.0 - 39.0	9.30 - 90.0	102	1	**FIP-30**
45.0	1.5	41.2 - 48.8	31.5 - 58.5	13.0 - 135	102	1	**FIP-45**
50.0	1.5	45.8 - 54.3	35.0 - 65.0	15.8 - 150	102	1	**FIP-50**
60.0	1.5	54.9 - 65.1	42.0 - 78.0	19.0 - 180	102	1	**FIP-60**
70.0	1.5	64.0 - 75.9	49.0 - 91.0	20.3 - 210	102	1	**FIP-70**
100	1.5	91.5 - 108.5	70.0 - 130	30.3 - 300	102	1	**FIP-100**
120	1.5	109.8 - 130.2	84.0 - 156	36.0 - 360	102	1	**FIP-120**
140	1.5	128.1 - 151.9	98.0 - 182	42.7 - 420	102	1	**FIP-140**

NOTE: All units meet or exceed applicable MIL-F-18327.
For other frequencies and impedances please contact us.
Impedance is 50 Ohms for all models.

For pin location and package outline drawings, see back pages.

PIN-OUT TABLE

INPUT	OUTPUT	CASE GROUND
1	8	All Other

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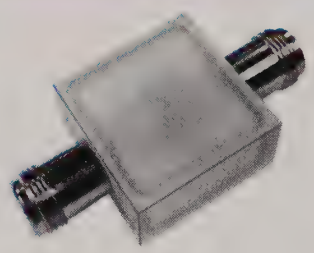
SYNERGY® MICROWAVE CORPORATION

DC BLOCK



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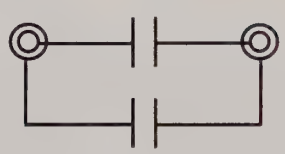
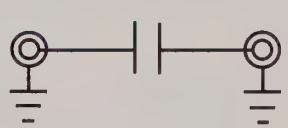
FREQUENCY RANGE: 1 - 1000 MHz

DC BLOCK

Because of their inherent high breakdown potential, the DC Blocks are ideal for applications where a high voltage, DC or AC up to 20 KHz, must be rejected from the RF signal path. Leakage from modulating signals can occur via AC power lines, through ground loops, or along poorly grounded coaxial cables. These leakages can impair the accuracy of RF measurements, and or signal purity.



DUAL BLOCK



SINGLE BLOCK

FREQUENCY RANGE (MHz)	INSERTION LOSS (dB) LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	VOLTAGE BREAKDOWN (Vdc)	VSWR LB TYP/MAX	MB TYP/MAX	UB TYP/MAX	TYPE	MODEL
3-500	0.06/0.20	0.04/0.20	0.10/0.20	2500	1.12:1/1.20:1	1.08:1/1.20:1	1.12:1/1.25:1	Single	**BLK-711N**
5-500	0.12/0.20	0.10/0.20	0.12/0.25	2500	1.18:1/1.25:1	1.12:1/1.20:1	1.20:1/1.30:1	Dual	**BLK-721N**
1-1000	0.20/0.30	0.10/0.20	0.40/0.50	2500	1.40:1/1.50:1	1.10:1/1.20:1	1.40:1/1.50:1	Single	**BLK-712N**
3-900	0.25/0.40	0.15/0.30	0.30/0.40	2500	1.18:1/1.25:1	1.23:1/1.32:1	1.35:1/1.45:1	Dual	**BLK-722N**

NOTE: For different connector requirements, please contact Synergy.
Impedance is 50 Ohms for all models.

LB = LF to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF

For package outline drawing, see back pages.

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SYNERGY® MICROWAVE CORPORATION

SILICON BIPOLAR MONOLITHIC AMPLIFIERS

ELECTRICAL SPECIFICATIONS

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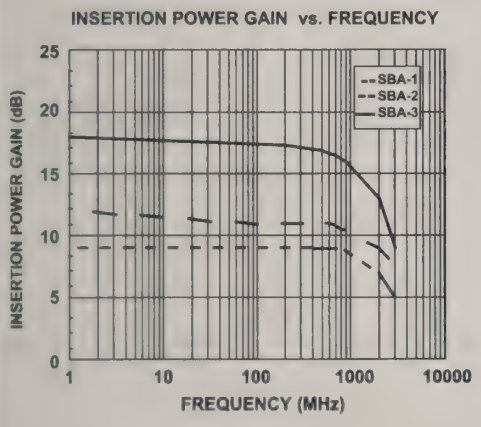
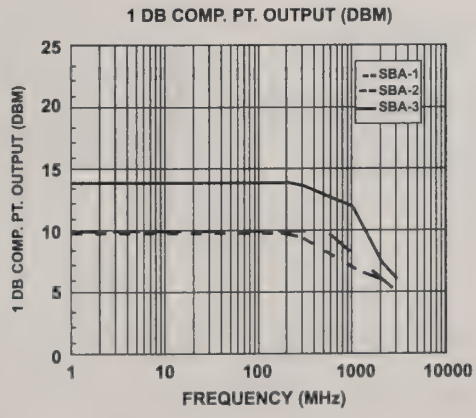
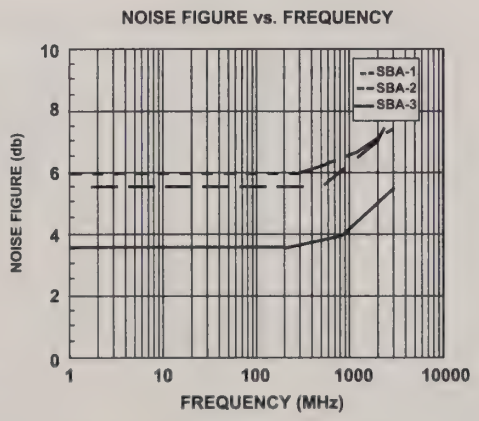
MODEL	SBA-1	SBA-2	SBA-3
Operating Frequency:	DC - 2000 MHz	DC - 2000 MHz	DC - 2000 MHz
Gain (dB):	Typ / Min	Typ / Min	Typ / Min
100 MHz:	9.0 / 7.0	11.0 / 10.5	18.0 / 12.0
500 MHz:	9.0 / 7.0	10.5 / 10.0	16.5 / 11.0
1000 MHz:	8.5 / 6.5	9.5 / 9.0	15.0 / 10.0
2000 MHz:	6.8 / 5.5	7.8 / 6.0	10.0 / 7.5
Typical Output 1 dB Comp Pt.:			
100 MHz:	+12 dBm	+9 dBm	+14.8 dBm
500 MHz:	+12 dBm	+9 dBm	+13.7 dBm
1000 MHz:	+9.5 dBm	+8.5 dBm	+11.8 dBm
2000 MHz:	+6.5 dBm	+8.0 dBm	+10.5 dBm
Typical VSWR:	Input / Output	Input / Output	Input / Output
100 MHz:	1.3:1 / 1.5:1	1.3:1 / 1.5:1	1.1:1 / 1.5:1
500 MHz:	1.3:1 / 1.5:1	1.3:1 / 1.5:1	1.2:1 / 1.5:1
1000 MHz:	1.3:1 / 1.5:1	1.3:1 / 1.5:1	1.2:1 / 1.5:1
2000 MHz:	1.3:1 / 1.5:1	1.3:1 / 1.5:1	1.3:1 / 1.5:1
Typical Noise Figure:			
100 MHz:	6.0 dB	5.5 dB	3.5 dB
500 MHz:	6.2 dB	6.0 dB	3.5 dB
1000 MHz:	6.5 dB	6.2 dB	4.0 dB
2000 MHz:	7.0 dB	7.0 dB	5.0 dB

TYPICAL PERFORMANCE CHARACTERISTICS







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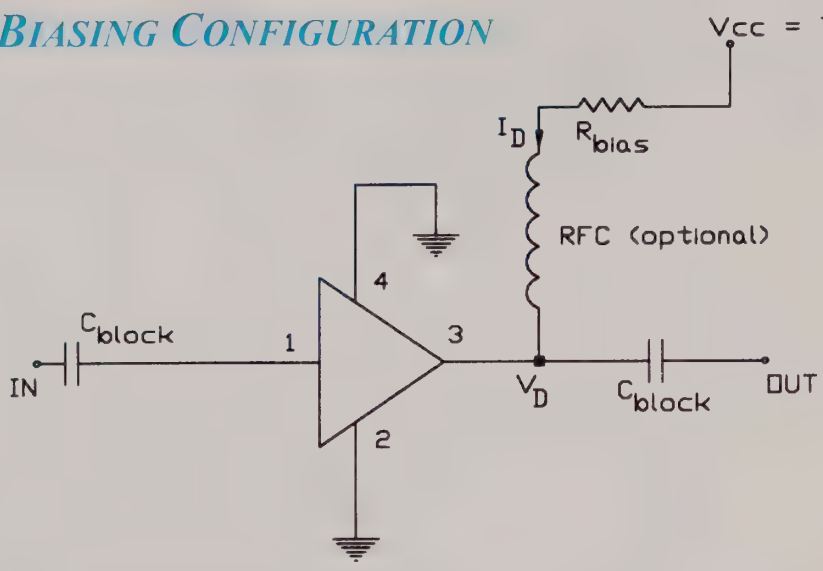
SYNERGY® MICROWAVE CORPORATION

SILICON BIPOLAR MONOLITHIC AMPLIFIERS

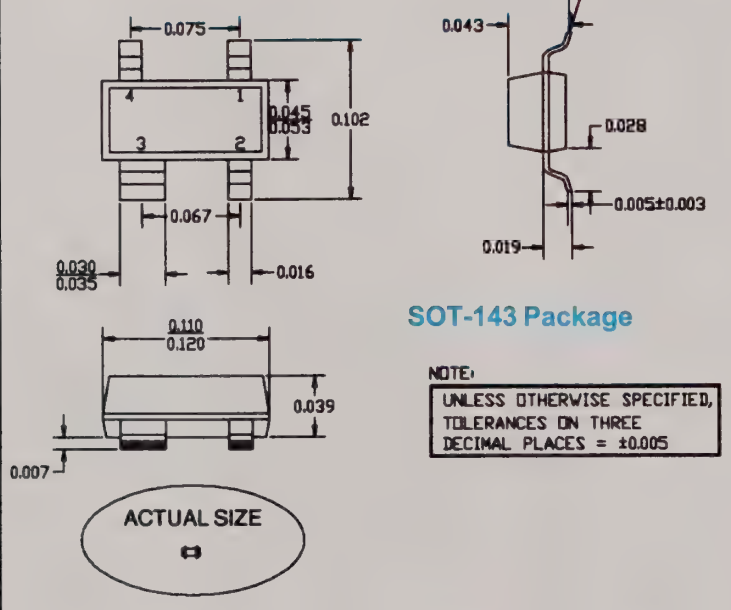
TYPICAL BIASING CONFIGURATION



$$R_{bias} = \frac{V_{CC} - V_D}{I_D}$$

V_D = 4.7V

MECHANICAL OUTLINE



SOT-143 Package

NOTE:
UNLESS OTHERWISE SPECIFIED, TOLERANCES ON THREE DECIMAL PLACES = ±0.005

MAXIMUM RATINGS

Parameter	Symbol	Unit
Device Current	I_D	60 mA
Total Power Dissipation, T_s < 99 °C	P_{tot}	250 mW
RF Input Power	P_{RFin}	10 dBm
T_s = Case Temperature		
Junction Temperature	T_j	150°C
Ambient Temperature	T_A	-45 to +85°C
Storage Temperature	T_{stg}	-65 to +150°C

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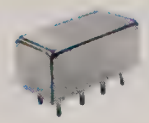
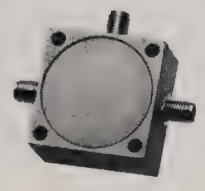
SYNERGY® MICROWAVE CORPORATION

ATTENUATORS / SWITCHES

Through-Hole
8-PIN RELAY HEADER



FREQUENCY RANGE (MHz) LF-HF	INSERTION (dB) LOSS XMB TYP/MAX	INSERTION (dB) LOSS FULL BAND TYP/MAX	ISOLATION (dB) LOSS LB TYP/MAX	ISOLATION (dB) LOSS MB TYP/MAX	ISOLATION (dB) LOSS UB TYP/MAX	SWITCH SPEED TYP	1dB COMP PT.(dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
1-200	1.4/2.0	1.6/2.5	65/50	50/40	50/35	2µsec	0	102	1	**AT-201**
5-400	5.5/6.5	6.0/7.5	75/70	--	65/55	10nsec	0	102	2	**AT-213**
5-450	2.5/3.5	3.5/4.7	65/50	45/35	35/25	2µsec	0	102	1	**AT-203**
5-700	6.0/7.5	8.0/10.0	90/75	80/70	60/45	2µsec	0	102	1	**AT-214**
10-1000	3.5/5.5	6.5/8.5	50/40	40/30	35/25	2µsec	0	102	1	**AT-204**



Coaxial Connector

FREQUENCY RANGE (MHz) LF-HF	INSERTION (dB) LOSS XMB TYP/MAX	INSERTION (dB) LOSS FULL BAND TYP/MAX	ISOLATION (dB) LOSS LB TYP/MAX	ISOLATION (dB) LOSS MB TYP/MAX	ISOLATION (dB) LOSS UB TYP/MAX	SWITCH SPEED TYP	1dB COMP PT.(dBm)	PACKAGE	PIN-OUT (See Below)	MODEL
5-400	5.5/6.5	6.0/7.5	75/70	--	65/55	10nsec	0	110	3	**AK-711***
5-450	2.5/3.5	3.5/4.7	65/50	45/35	35/25	2µsec	0	110	3	**AK-703***
5-700	6.0/7.5	8.0/10.0	90/75	80/70	60/45	2µsec	0	110	3	**AK-707***
10-1000	3.5/5.5	6.5/8.5	50/40	40/30	35/25	2µsec	0	110	3	**AK-706***

*Select Connector: "B" = BNC, "S" = SMA, "N" = TYPE N, "T" = TNC

LB = L F to 10 LF
MB = 10 LF to HF/2
UB = HF/2 to HF
XMB = 2 LF to HF/2
FULL BAND = LF to HF

PIN-OUT TABLE

	INPUT	OUTPUT	CONTROL	GROUND	CASE GND
# 1	1	8	*3,4	2,5,6,7	2
#2	1	8	*3,4	2,5,6,7	2,5,6,7
#3	1	8	2	--	--

* Connect together externally

For pin location and package outline drawings, see back pages.

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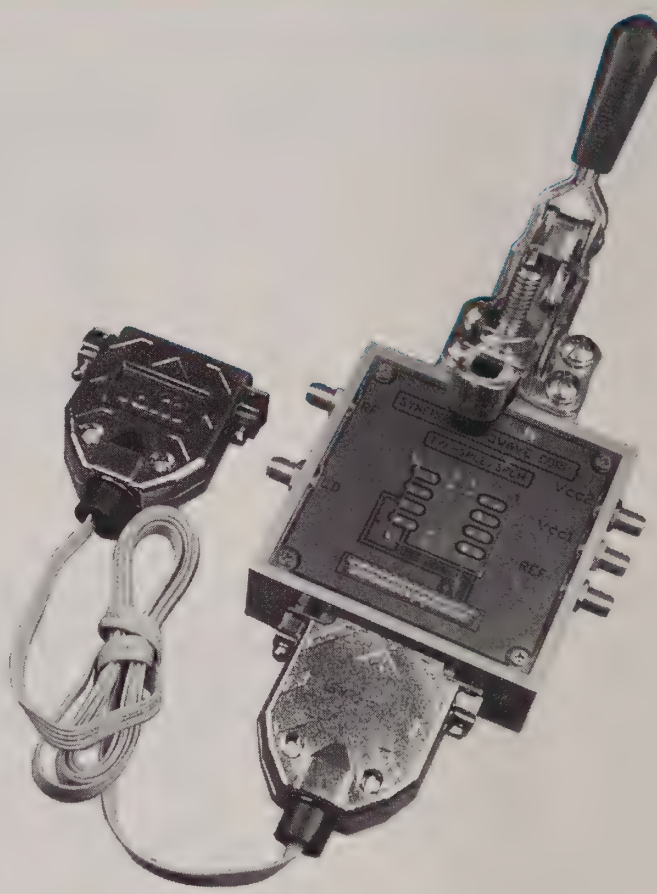
SYNERGY® MICROWAVE CORPORATION

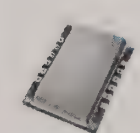
TEST FIXTURES

PLL Tool Kit ™
For Synthesizers

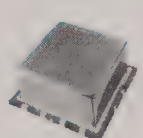


- Unit can be mounted directly on to the fixture and clamped without requiring any solder attachment to the fixture.
- All ports, other than programming ports are provided with SMA female connectors.
- Programming ports are hard wired using a flexible cable with matching connector for direct connection to the parallel port of the PC.
- A floppy disk containing an executable file is also provided along with the fixture.
- Step by step instructions are given in the menu to help set the different parameters like step size, reference frequency, frequency increment and output frequency.
- The fixtures have built-in power supply filtering.
- The fixtures are rugged in construction and reliable.

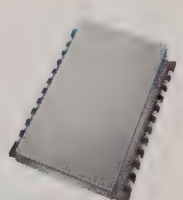
Available for package styles, 124S, 192 and 197



192



124s



197

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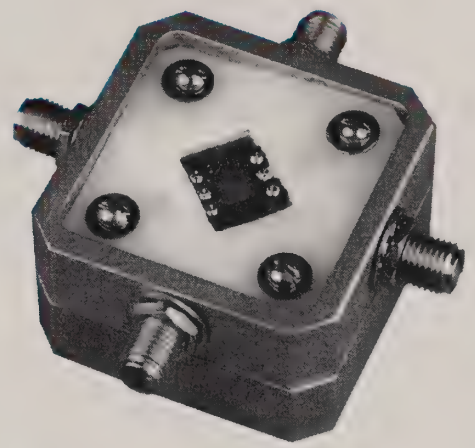
TEST FIXTURES

Quick Test ™

- Easy to use.
- Suitable for high volume testing.
- Compatible with different outlines of different pin layout.
- The fixtures are rugged in construction and reliable.
- Low cost.

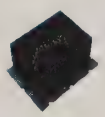


Available for package styles, 134,134S, 134J, 152, 133, 159

134

134S

134J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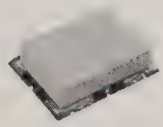
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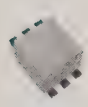
159

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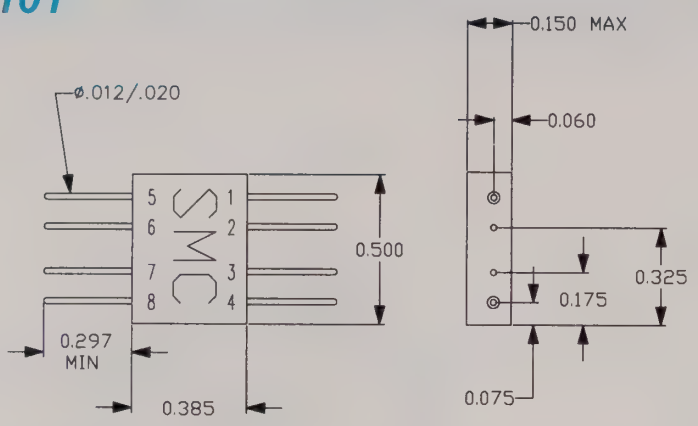
SYNERGY® MICROWAVE CORPORATION

OUTLINE DRAWINGS

101



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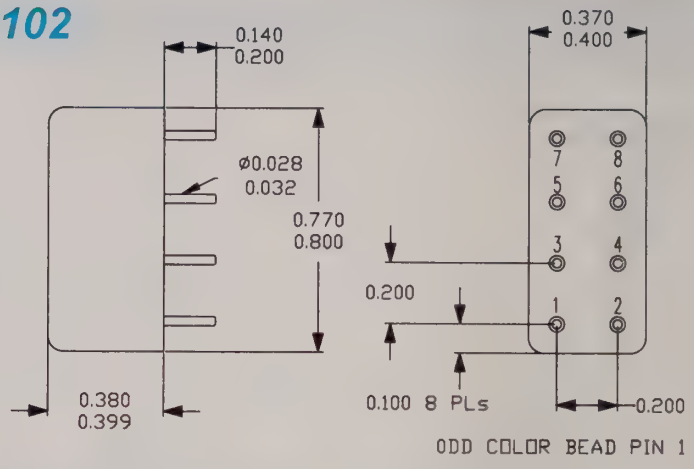
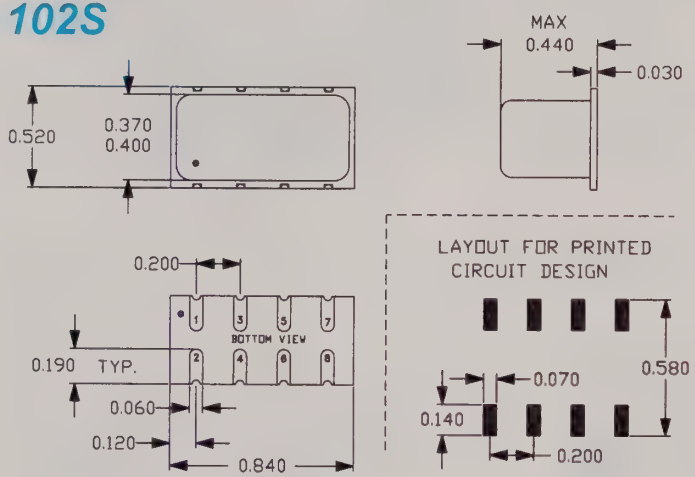
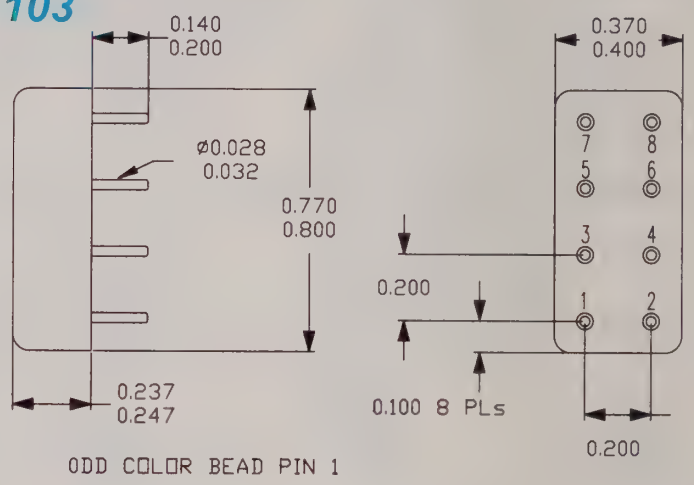


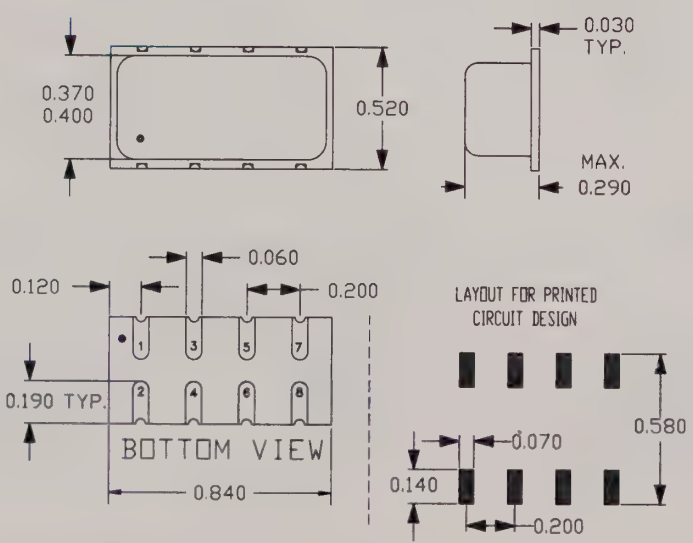
102S



103



103S



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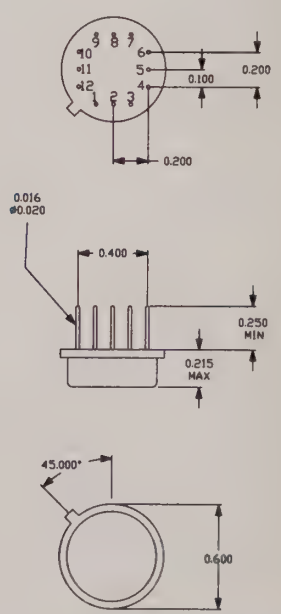

Unless otherwise specified, tolerances shall be: .x ±.1
.xx ±.03
.xxx ±.015

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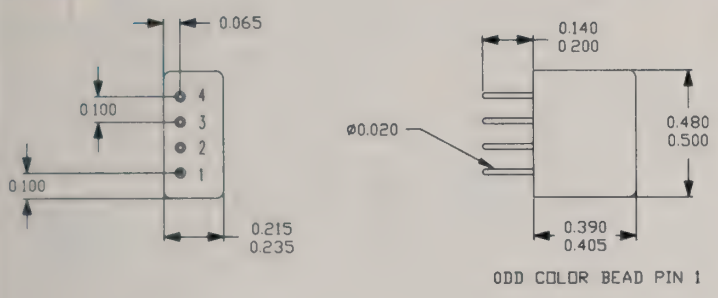
OUTLINE DRAWINGS

105



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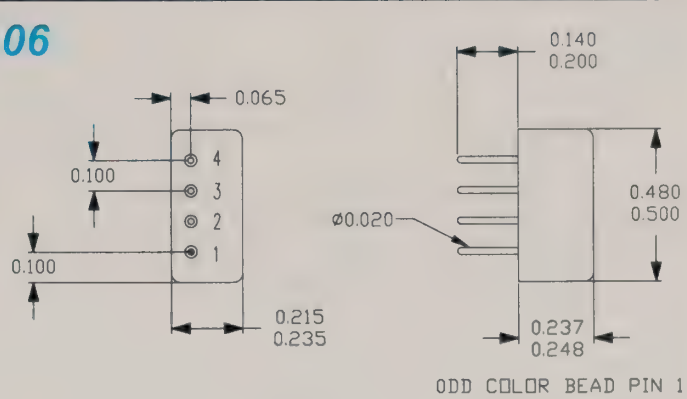

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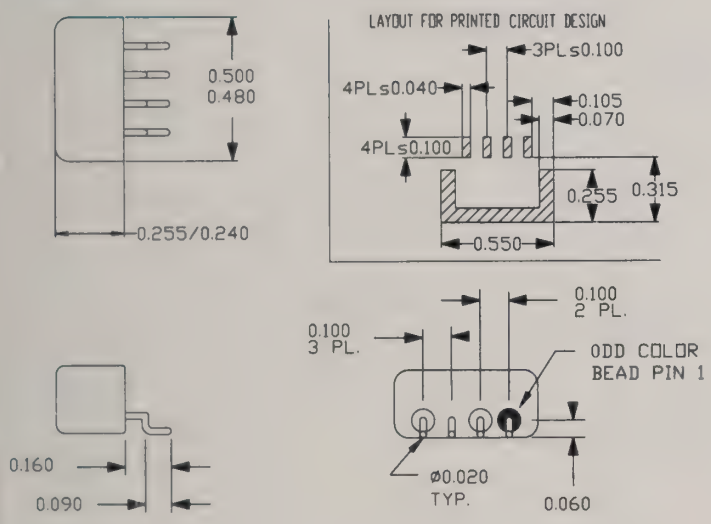

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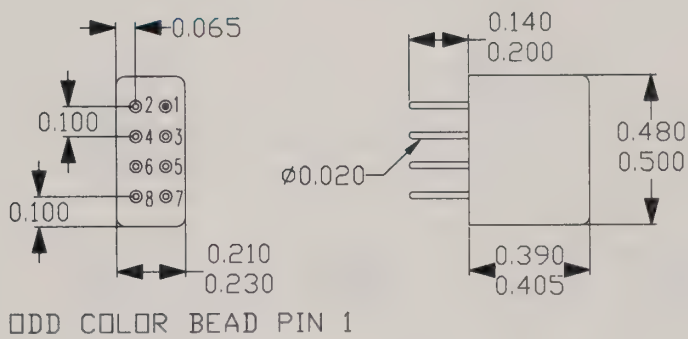

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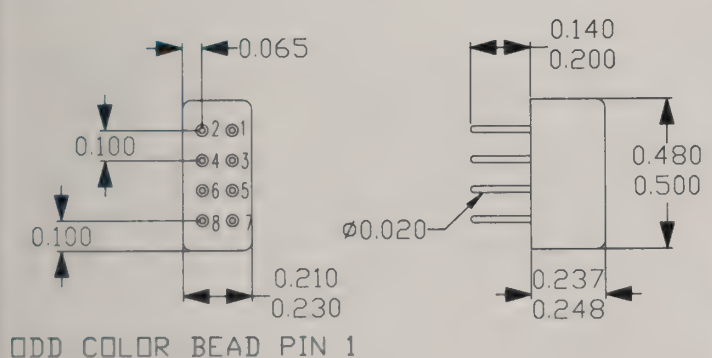

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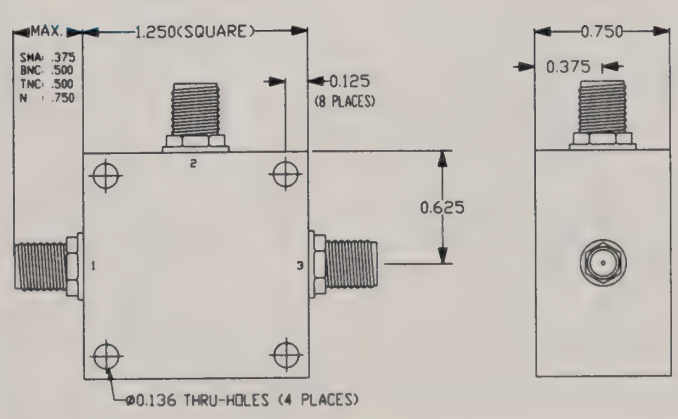

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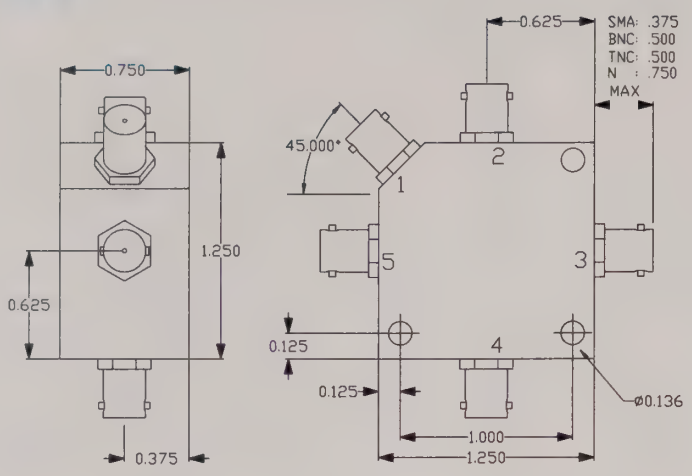

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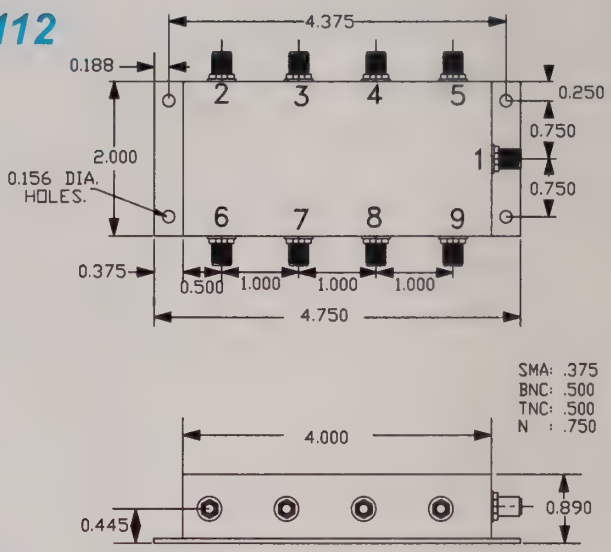

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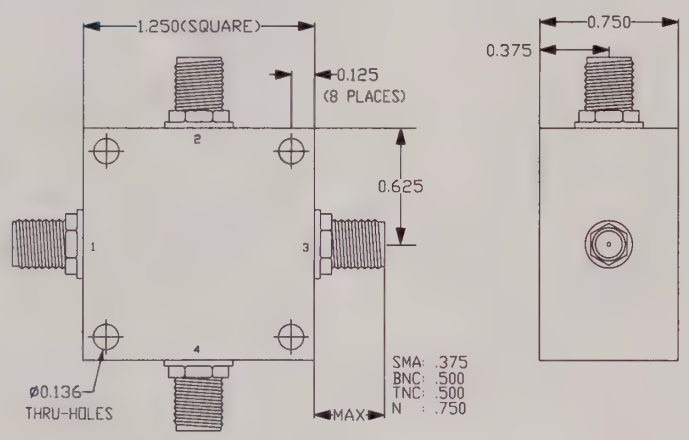

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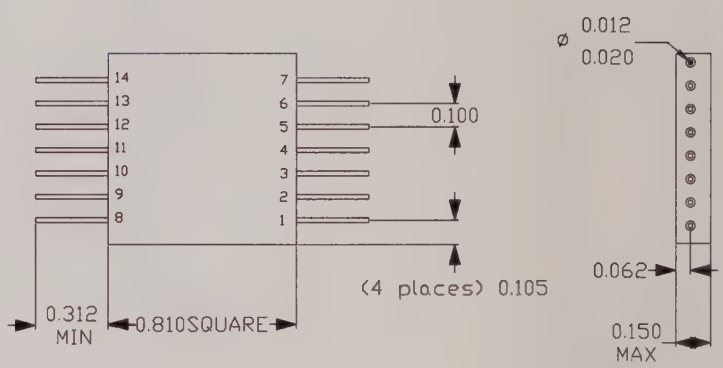

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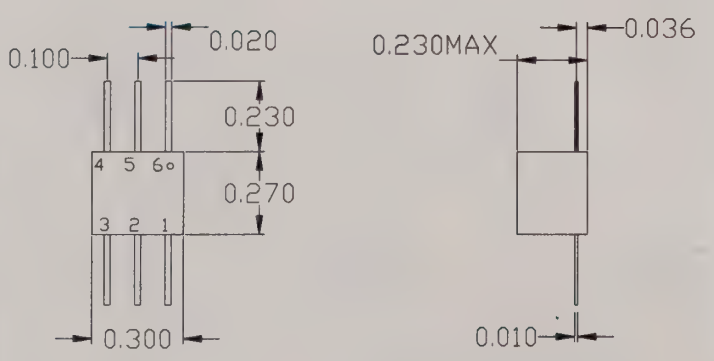

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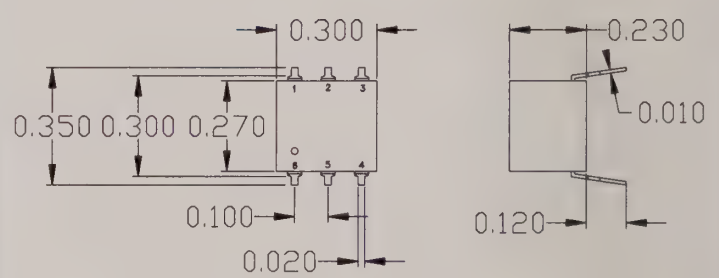

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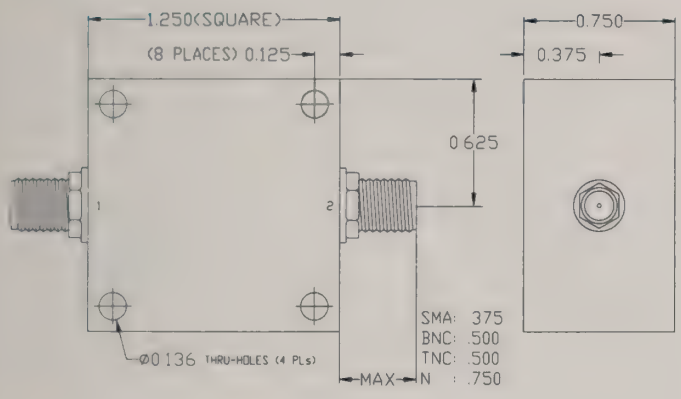

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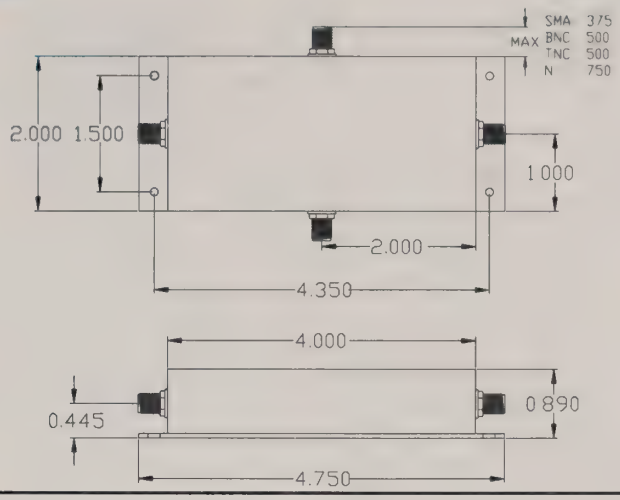

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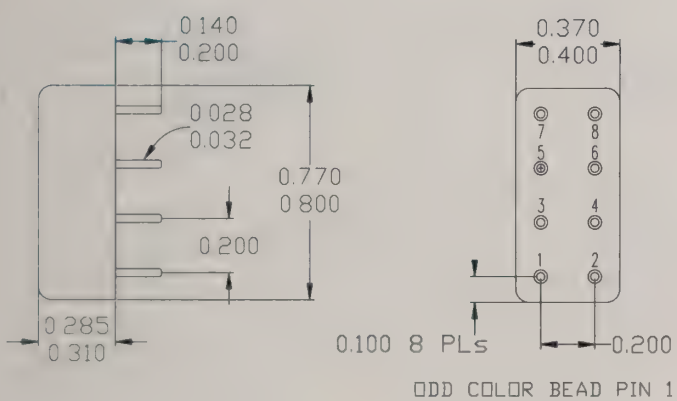

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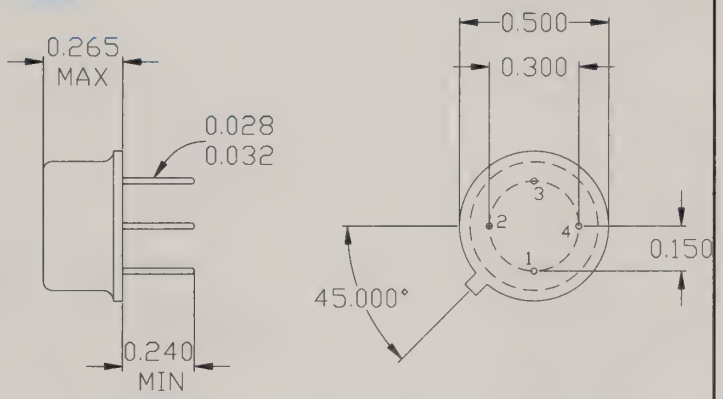

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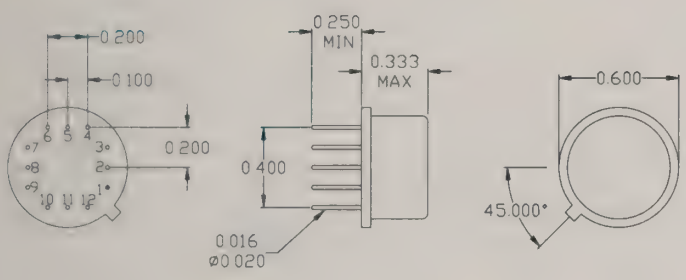

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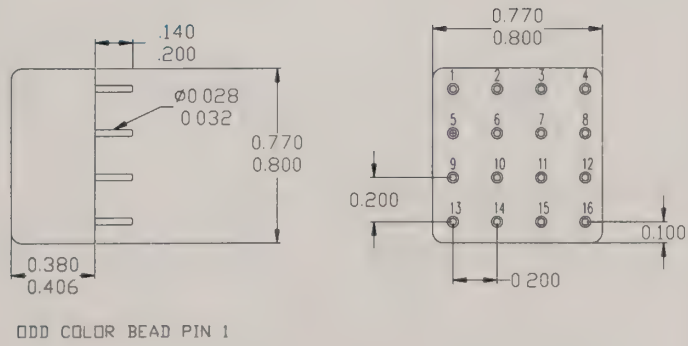

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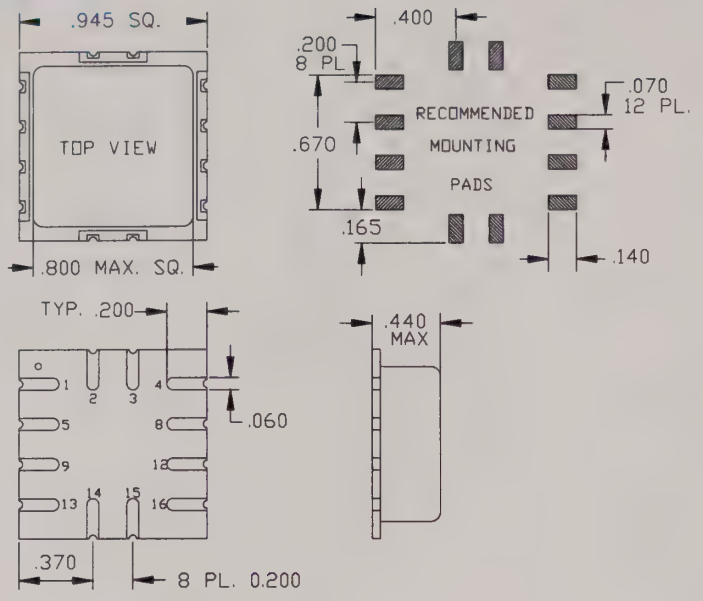

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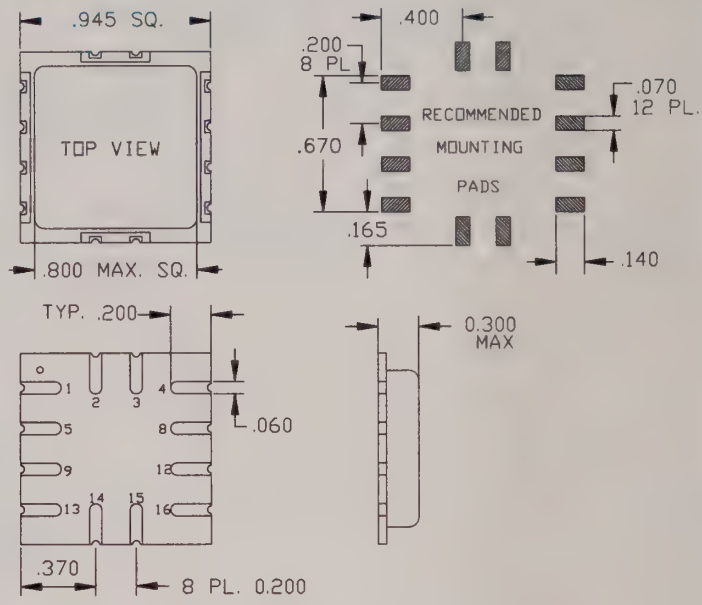

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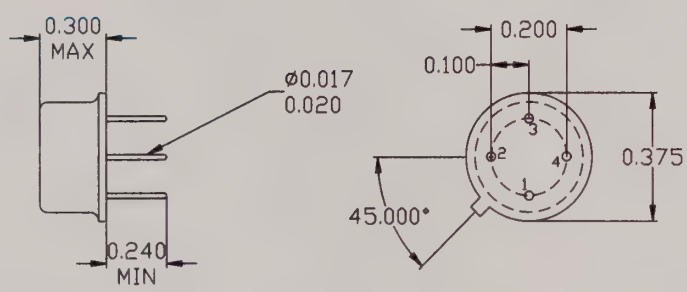

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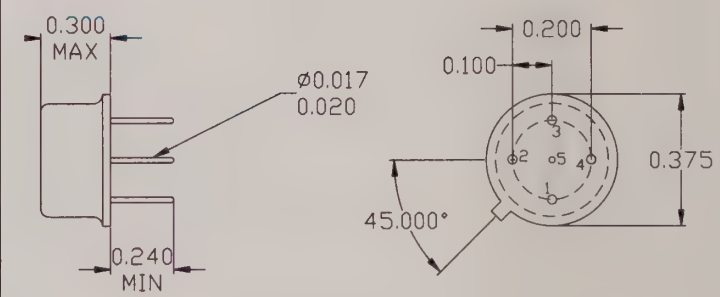

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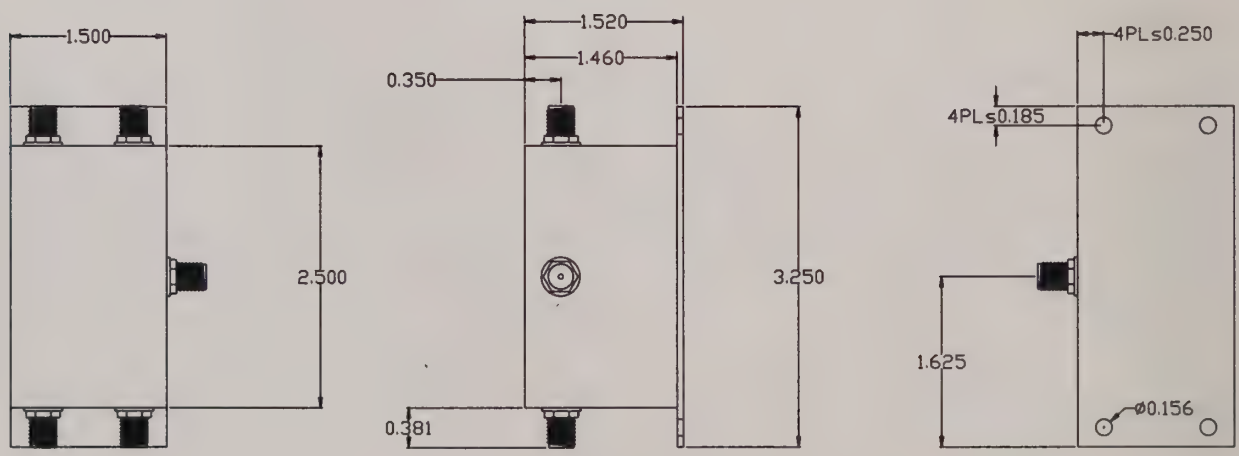

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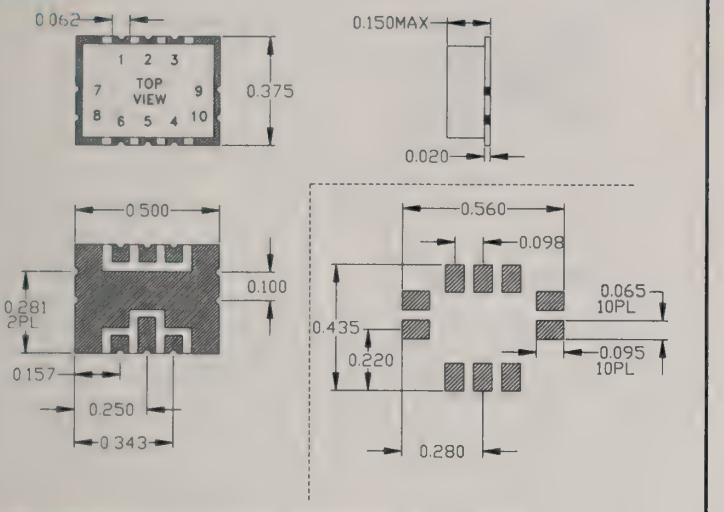

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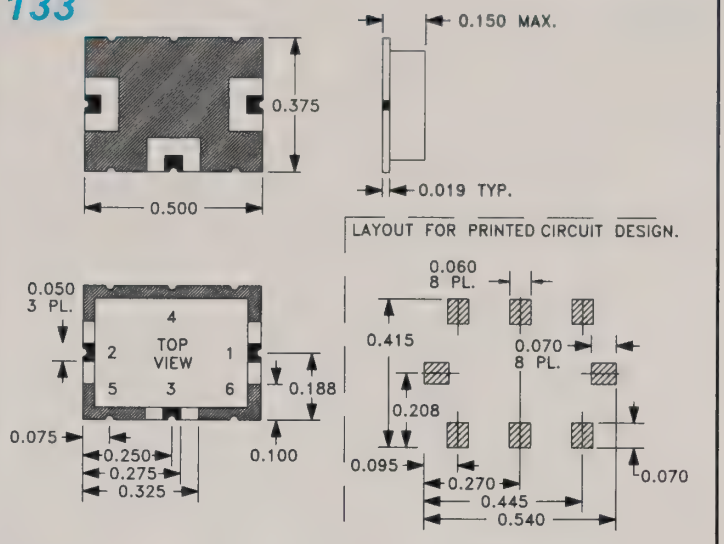

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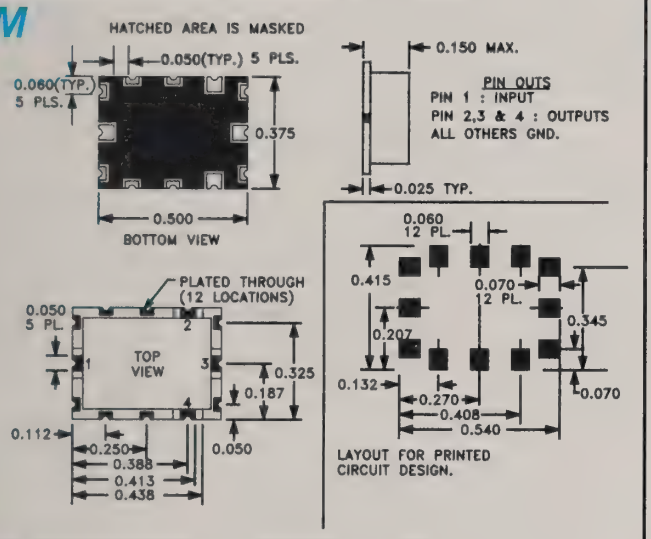

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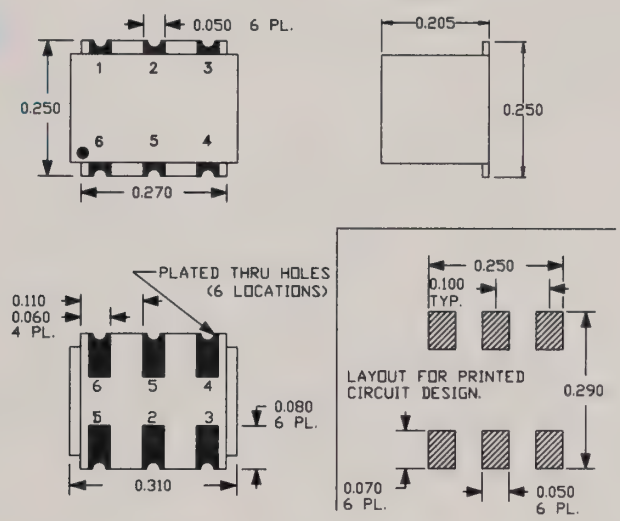

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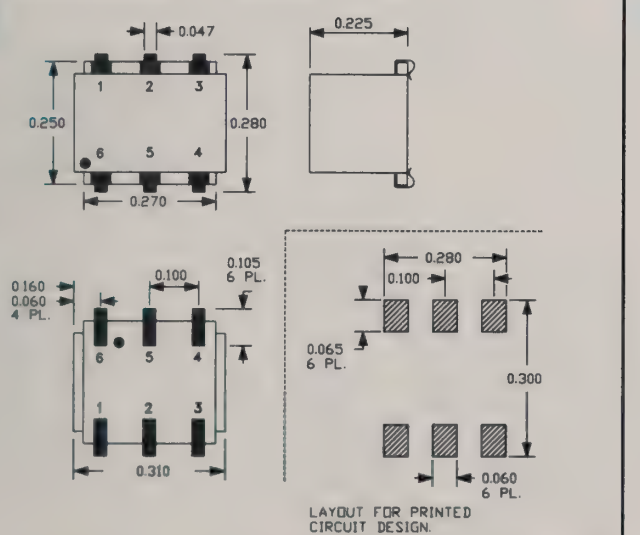

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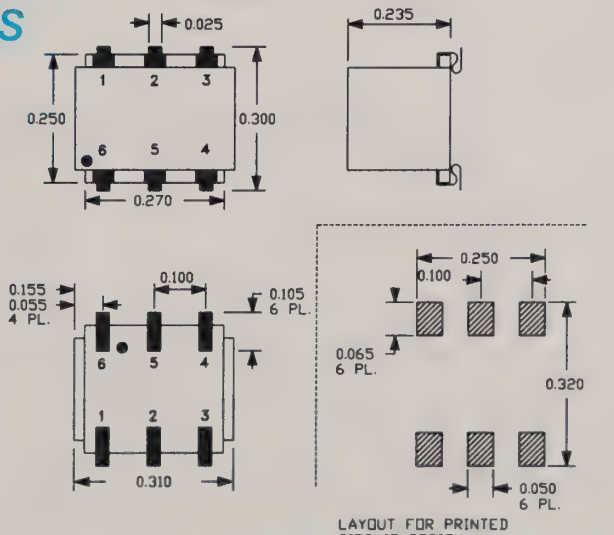

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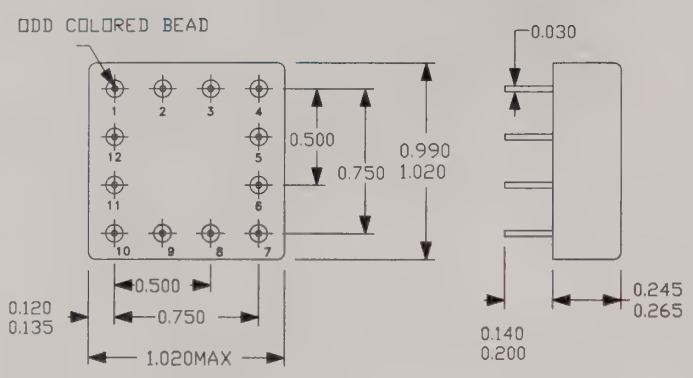

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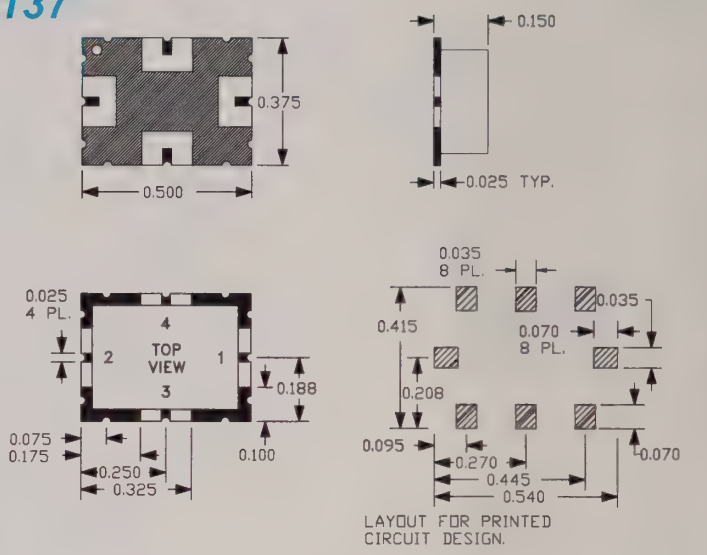

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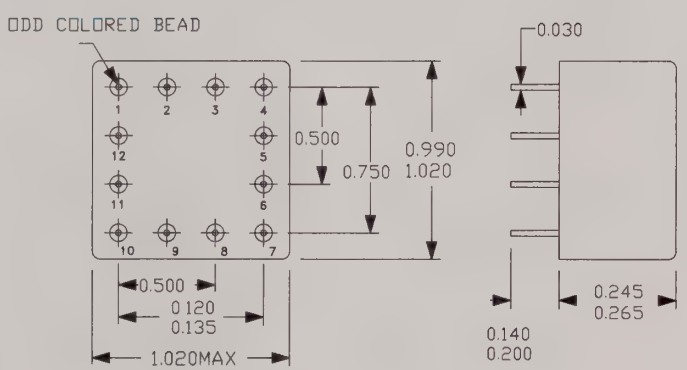

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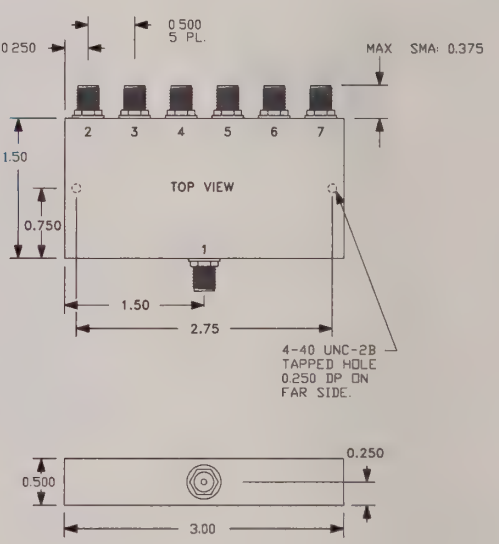

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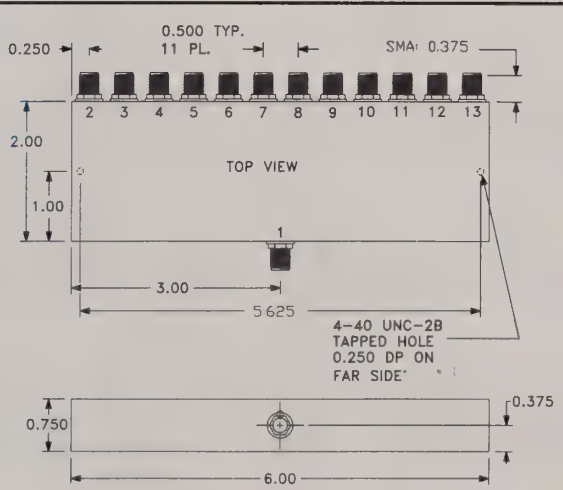

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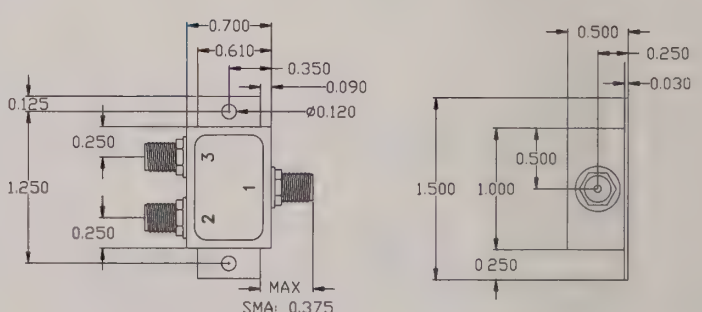

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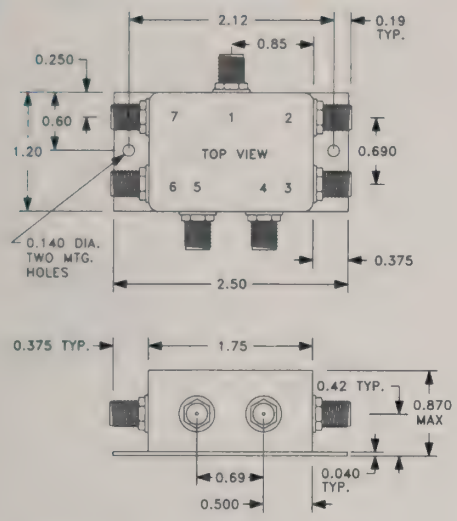

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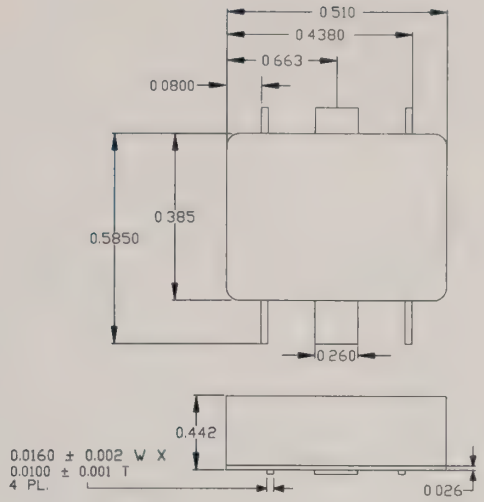

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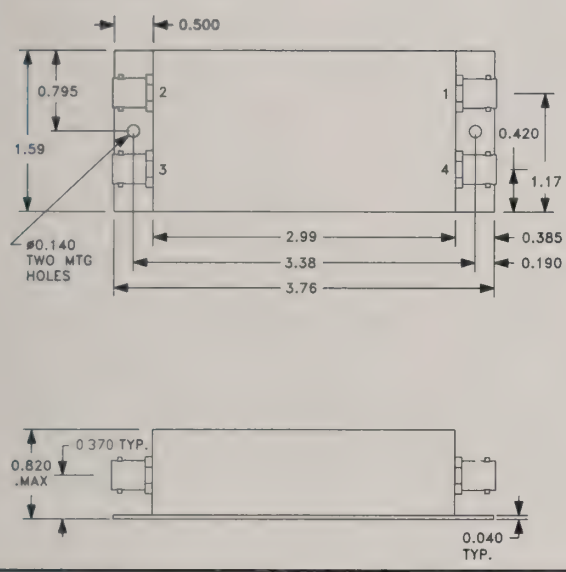

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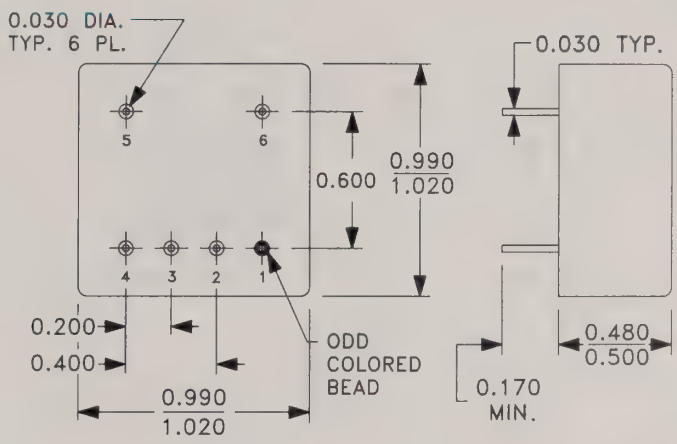

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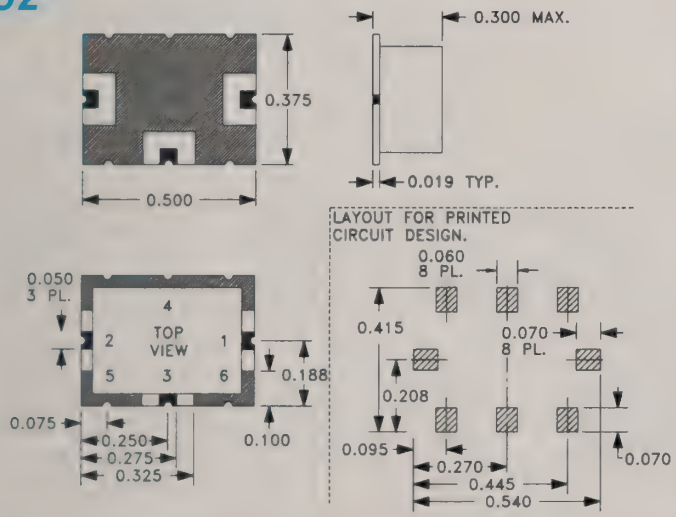

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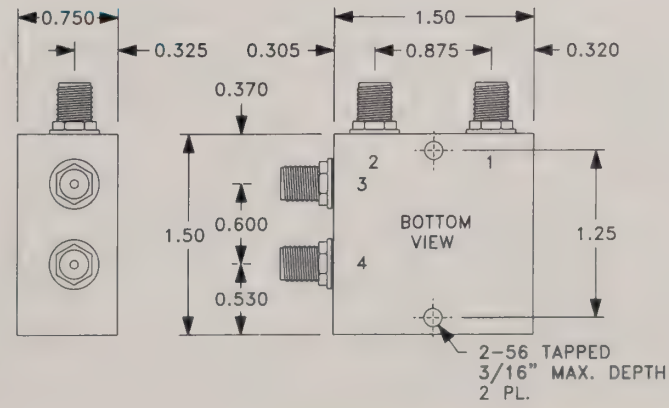

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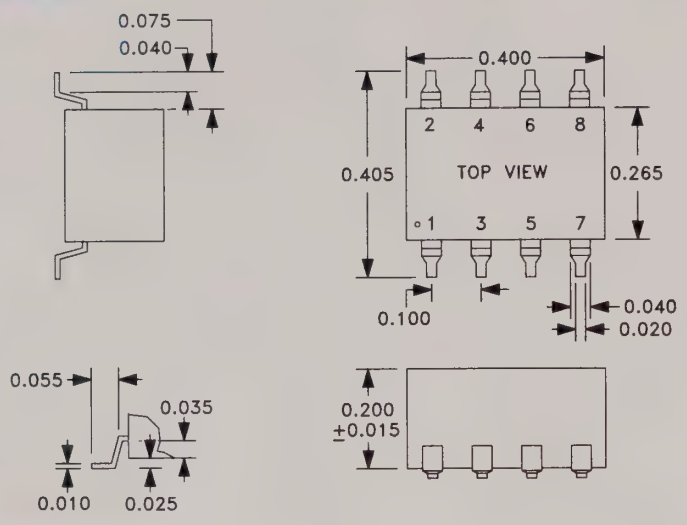

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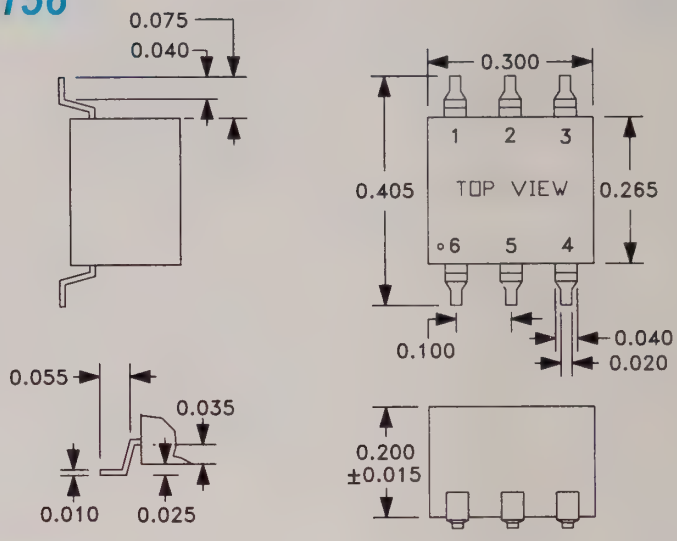

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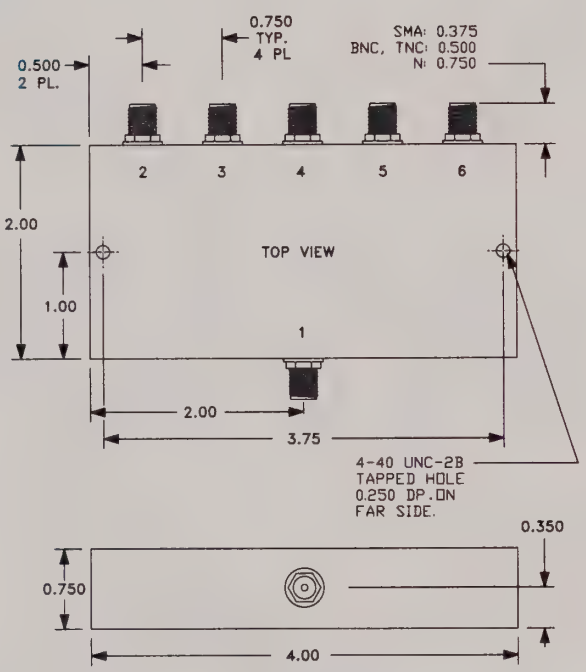

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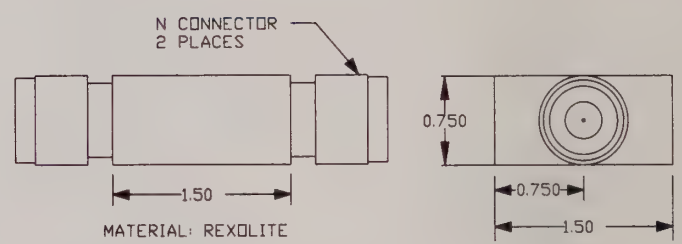

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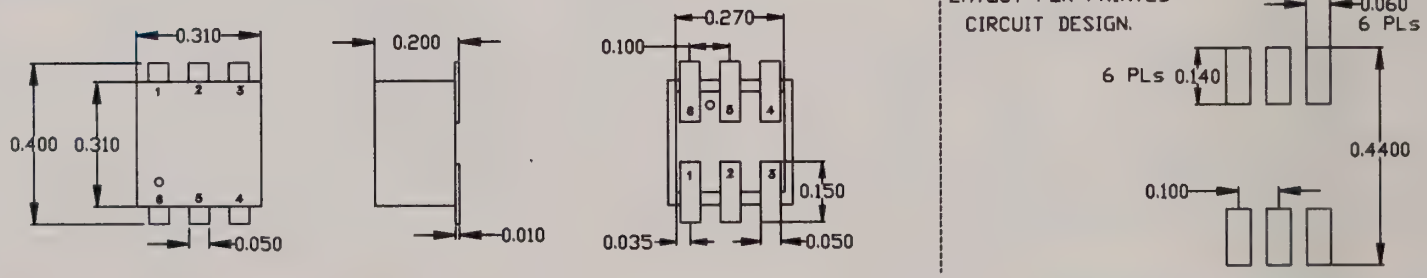

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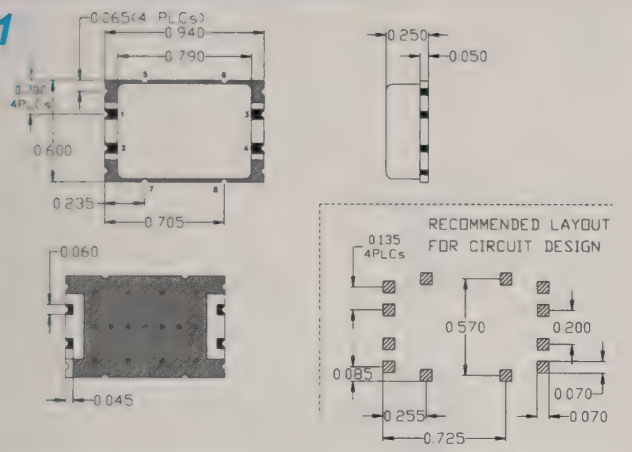

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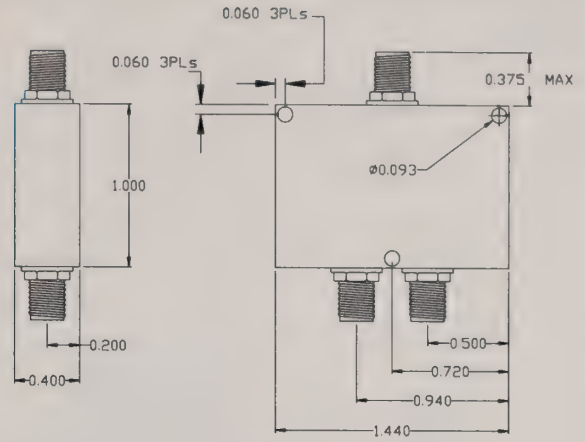

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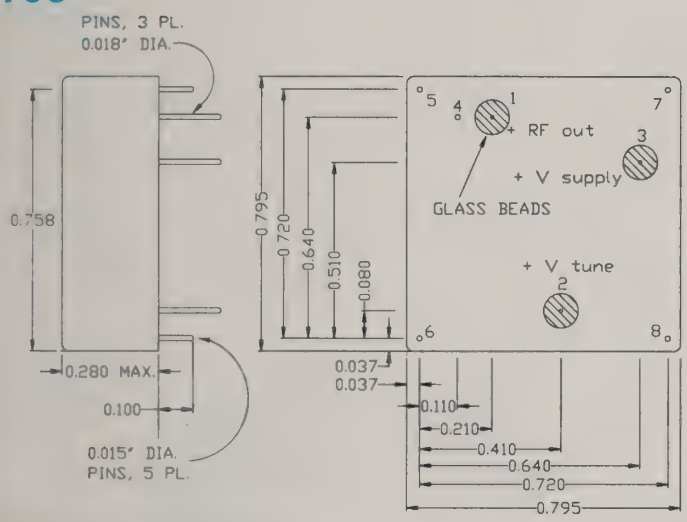

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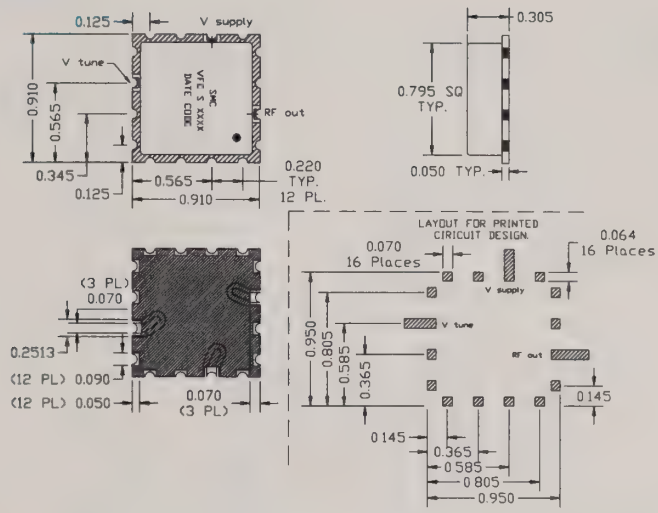

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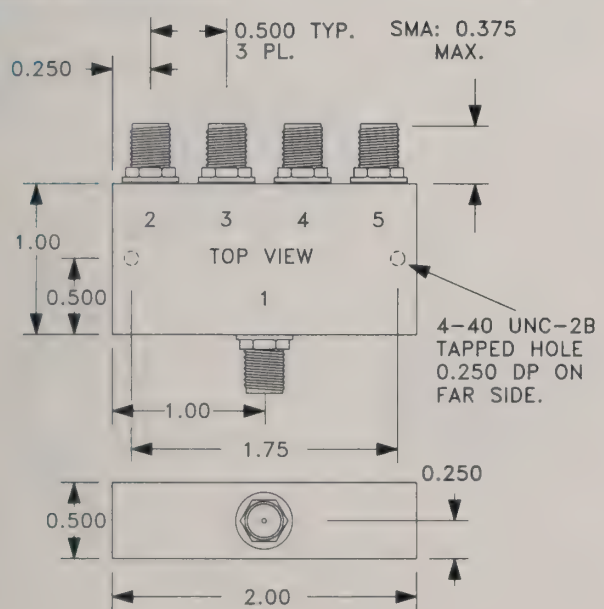

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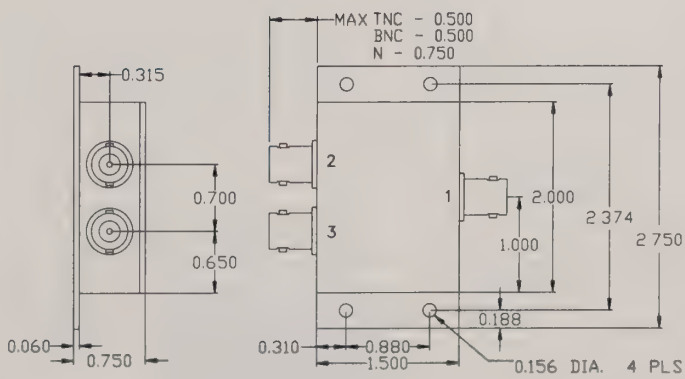

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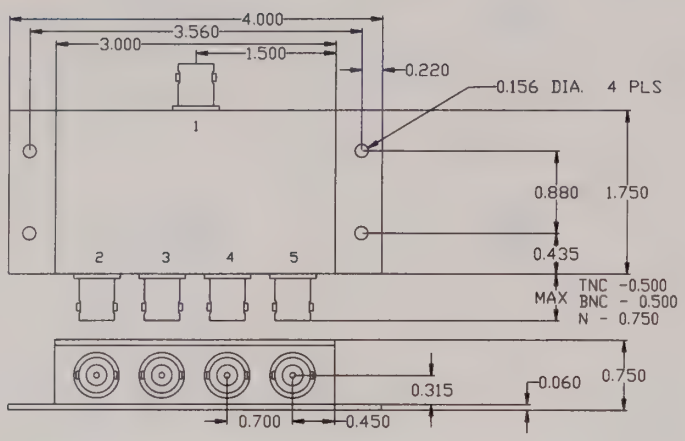

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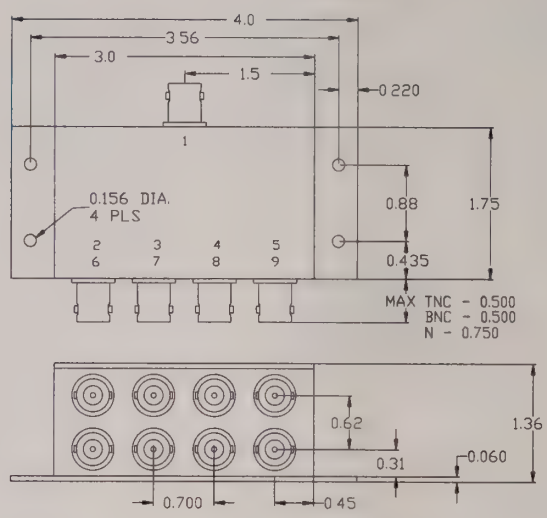

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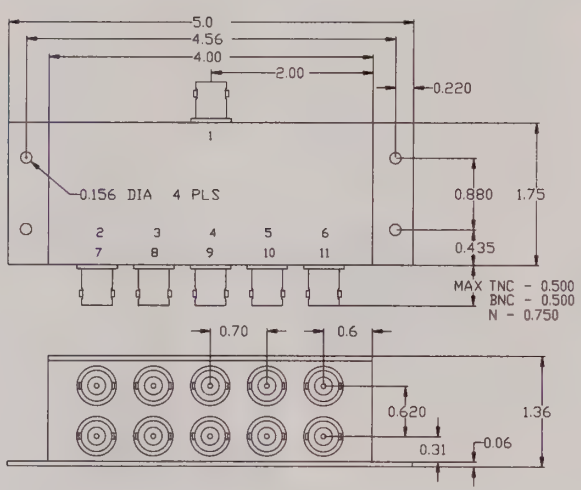

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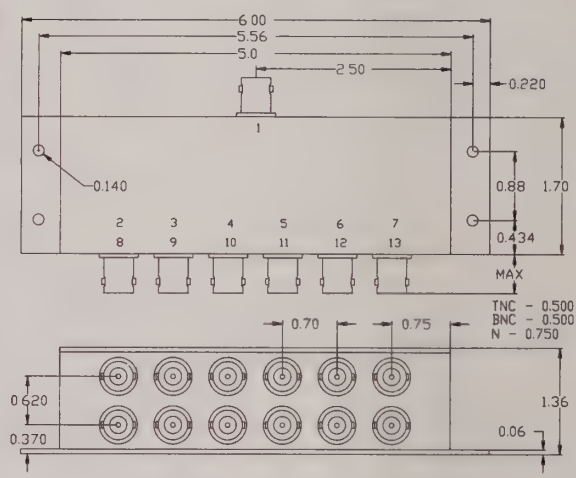

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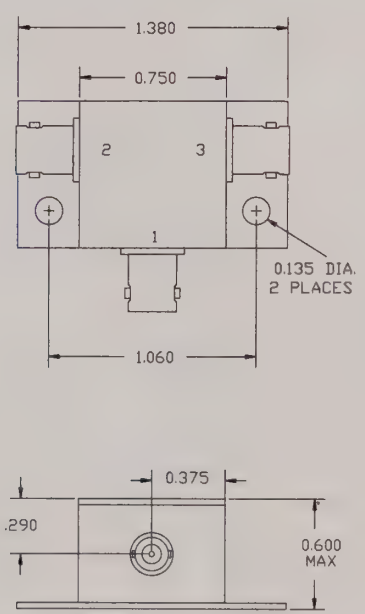

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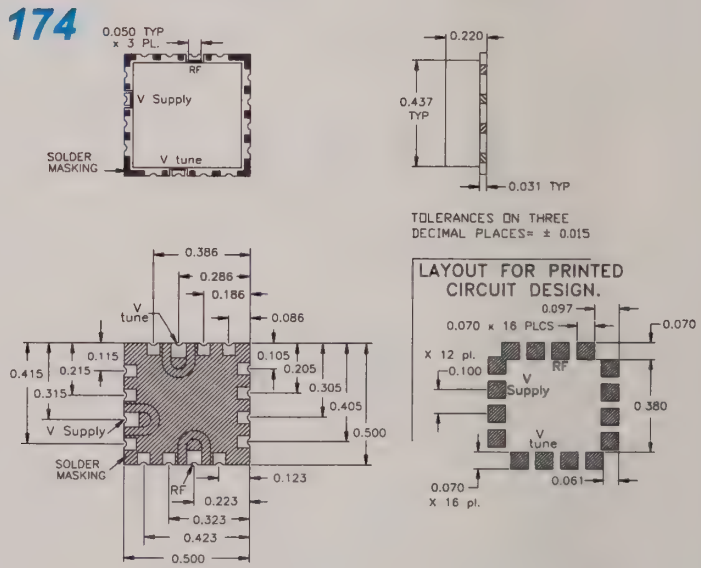

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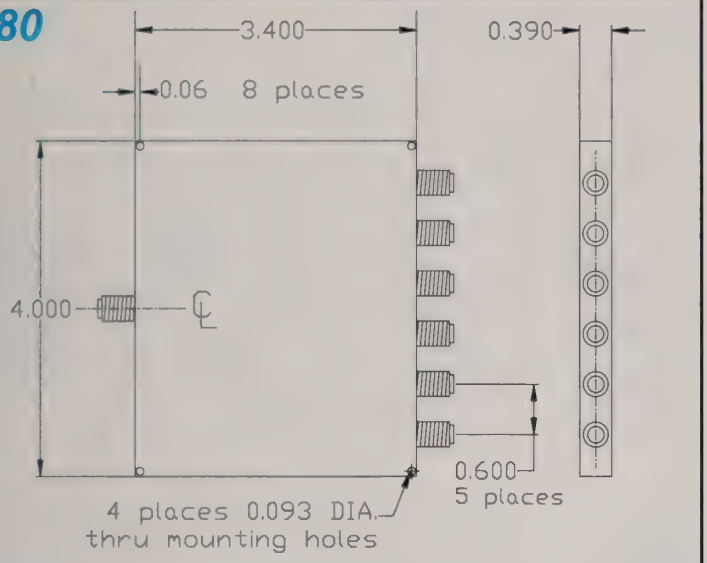

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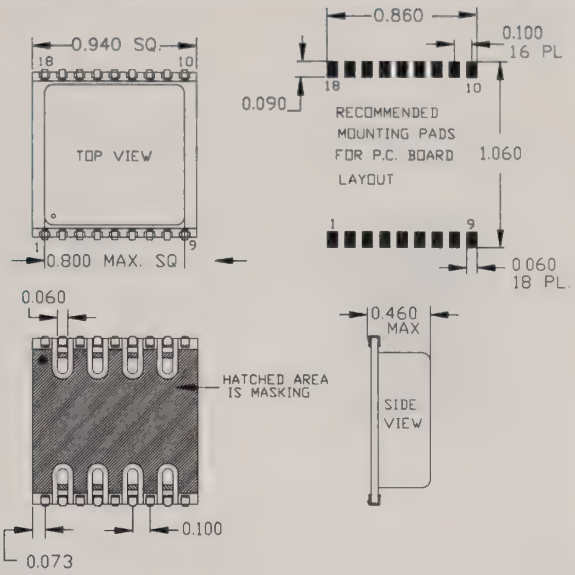

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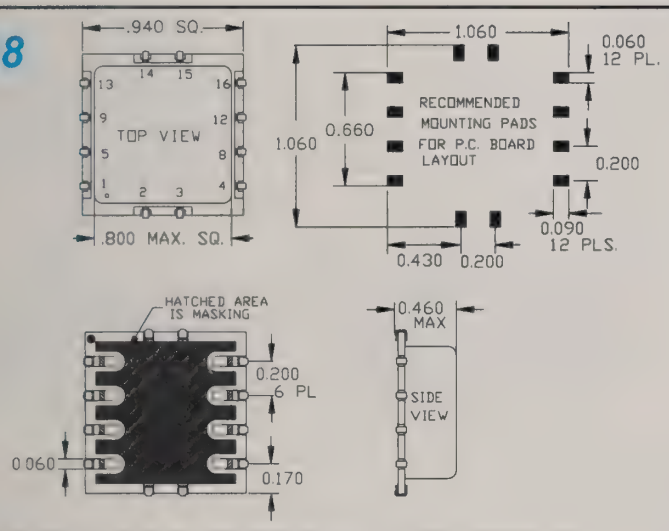

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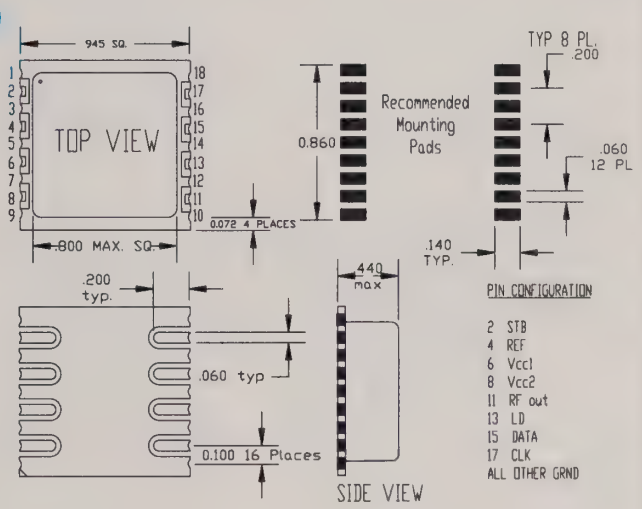

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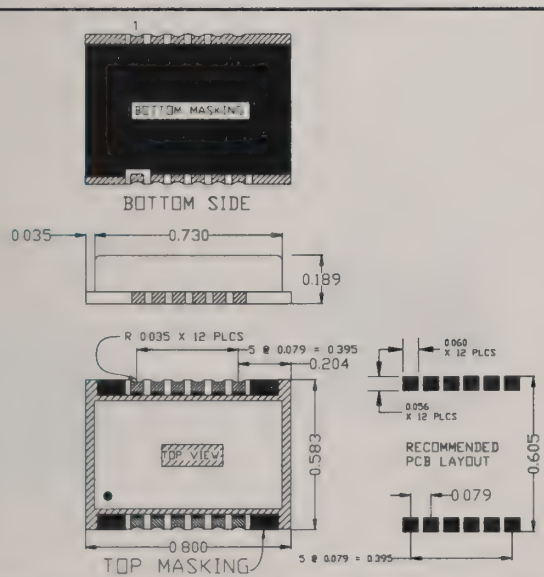

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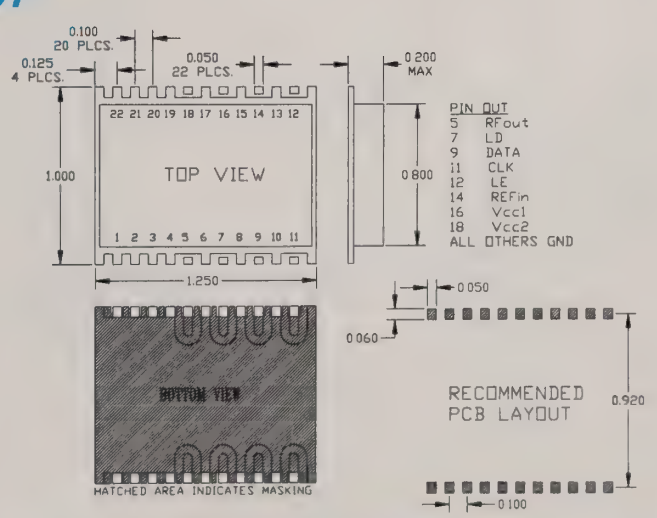

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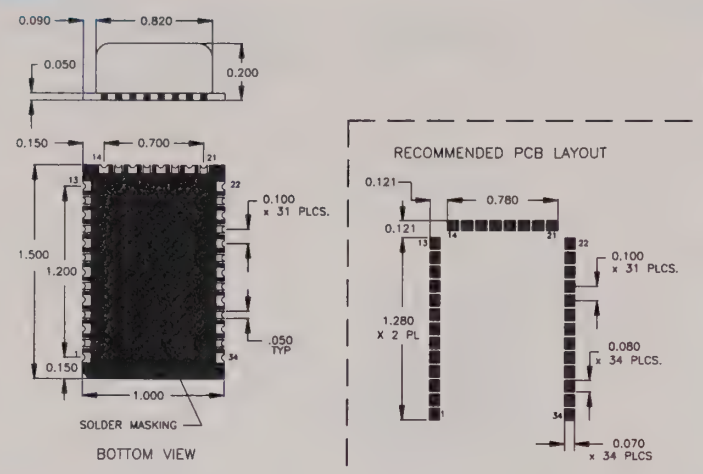

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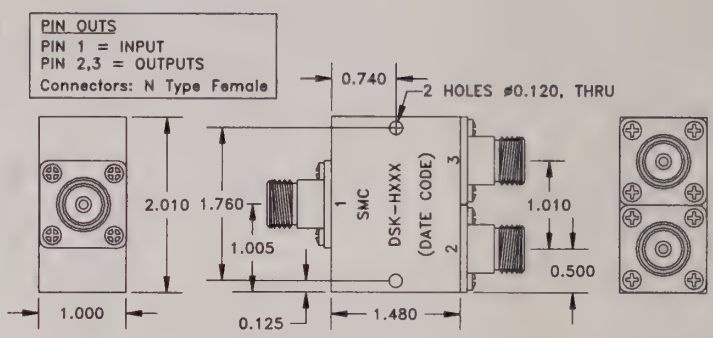

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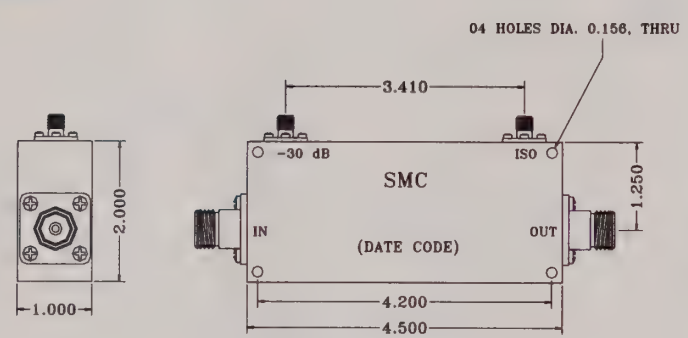

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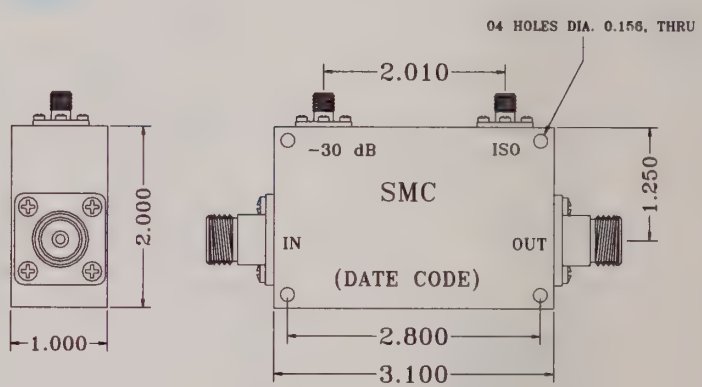

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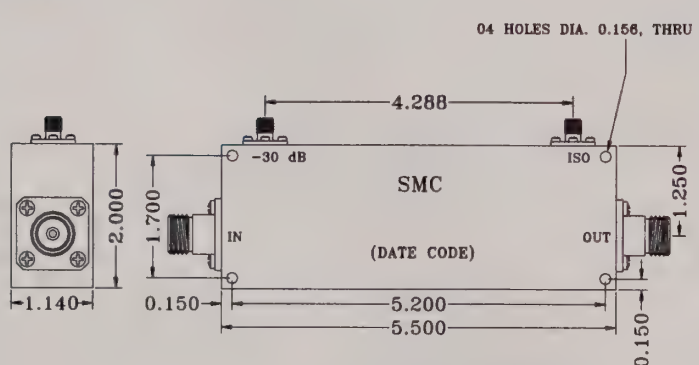

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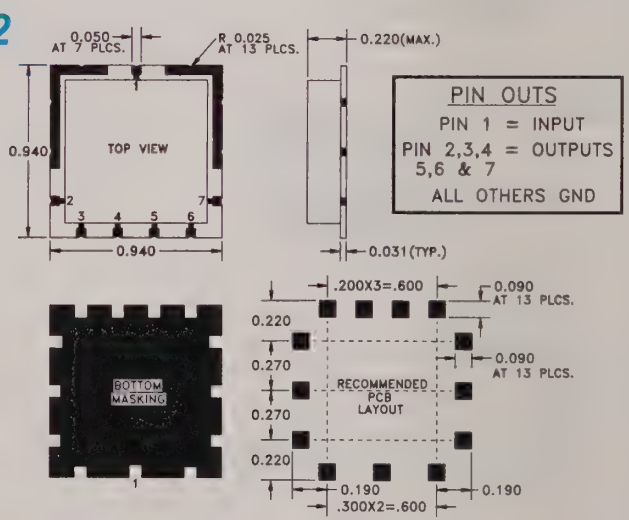

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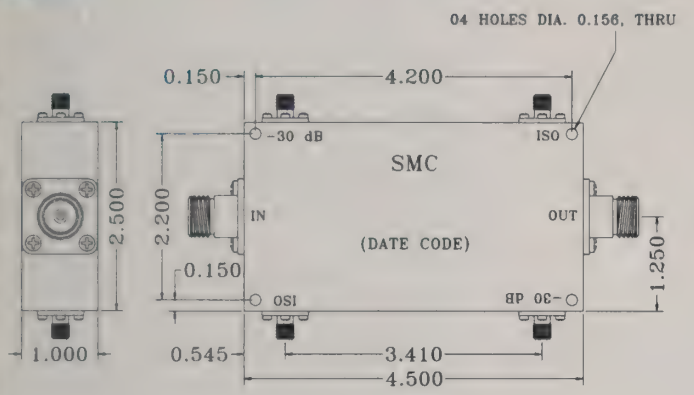

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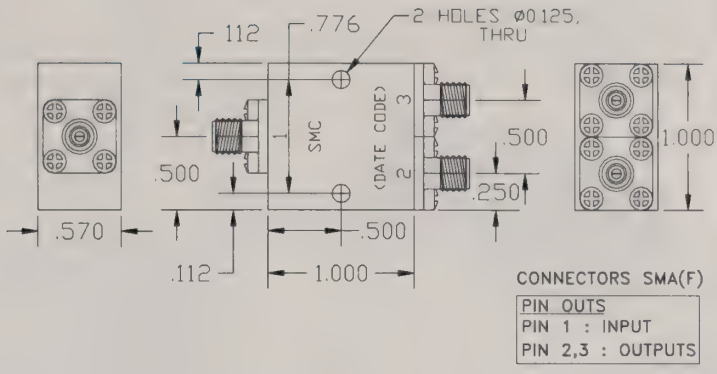

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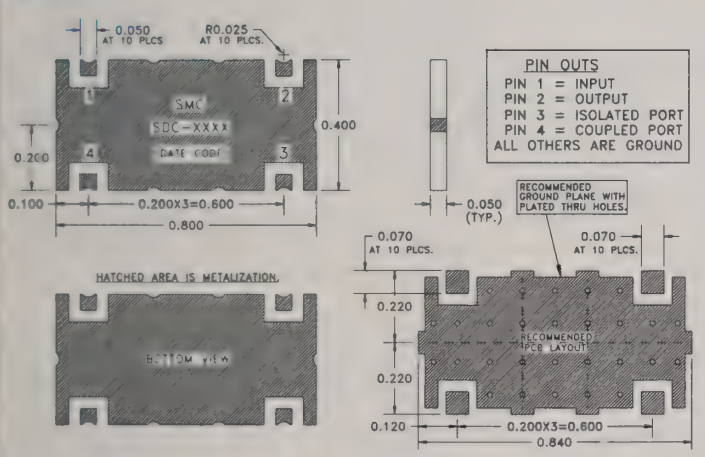

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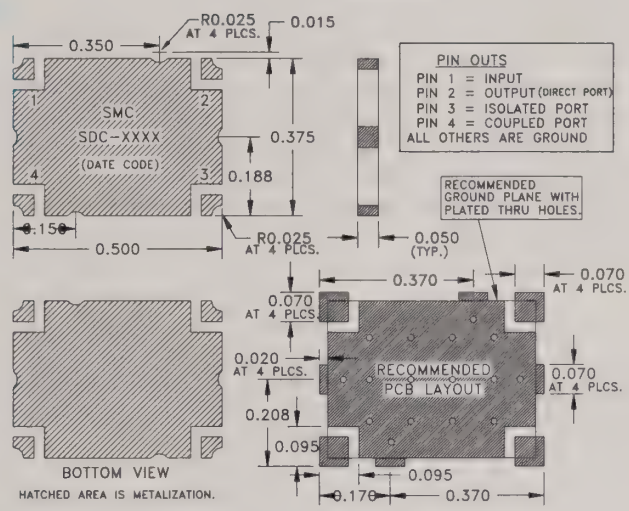

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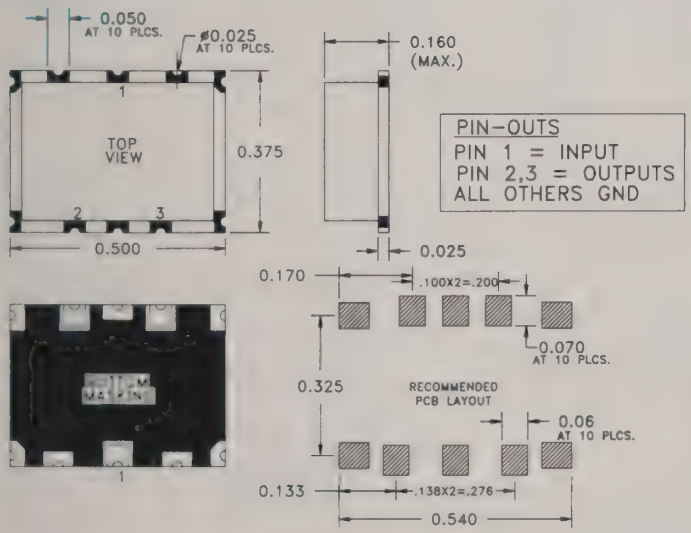

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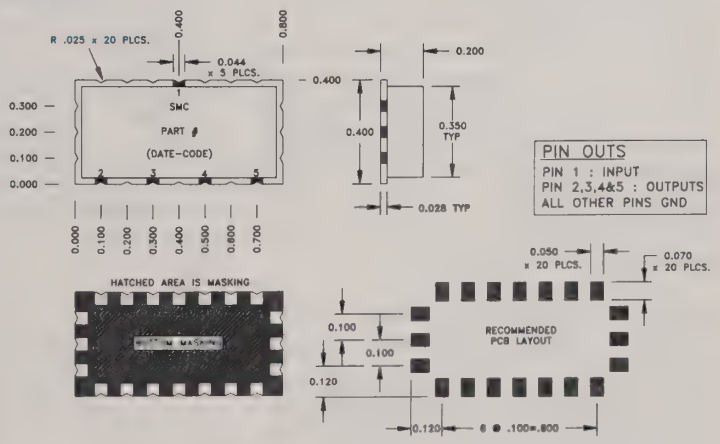

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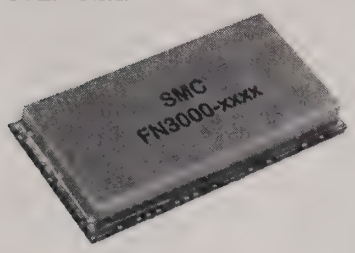
FRACTIONAL-*N* SYNTHESIZER

FEATURES:

- VERY LOW PHASE NOISE
- EXCELLENT STABILITY
- COAXIAL RESONATOR OSCILLATOR
- OPTIMIZED BANDWIDTHS
- LOOP NOISE INDEPENDENT OF STEP SIZE



SPECIFICATIONS: PRELIMINARY

Available Frequency (20 MHz bands):	**800 - 1200 MHz**
Maximum Bandwidth:	**20 MHz**
Step Size:	**1 KHz to 1 MHz**
Reference Input Frequency Range:	**130 MHz / 120 MHz**
Reference Input:	**+5 dBm to +10 dBm**
Bias Voltage:	**Vcc_1 = 5 VDC @ <150 mA**
	Vcc_2 = 5 VDC @ <250 mA
	Vcc_3 = 5 VDC @ <75 mA
	Vcc_4 = 9 VDC @ <50 mA
Output Power:	**+5 dBm upgradable to +18 dBm**
Output Impedance:	**50 Ω (Nom)**
Harmonic Suppression:	**15 dBc (Min)**
VSWR:	**1.8:1 (Nom)**
Typical Phase Noise:*	**-95 dBc/Hz @ 100 Hz offset**
	-100 dBc/Hz @ 1K Hz offset
	-110 dBc/Hz @ 10 KHz offset
	-130 dBc/Hz @ 100 KHz offset
	-150 dBc/Hz @ 1MHz offset
Programming:	**Serial**
Operating Temperature Range:	**-20° to +70°C**

DESCRIPTION:

Synergy's FN3000 series of Fractional-N Synthesizers consist of a transistor oscillator with a High Q ceramic resonator at the base. This very low noise voltage controlled oscillator is synchronized using Synergy's ultra low noise fractional N Custom PLL chip with a noise floor of less than -160 dBm. The advanced Fractional Division N implementation with digital compensation allows step sizes from 1 KHz to 1 MHz and exceptionally low phase noise to the carrier.

Synergy introduces a new series of fractional-N synthesizers that offer high resolution, fast switching and low phase noise compared to conventional PLL-based synthesizers. They combine the best of analog and digital technologies to provide this enhanced performance. Synergy's fractional-*N* synthesizers are most ideal for improved signal-to-noise ratio (SNR) and spurious-free dynamic range for cellular, PCS and similar base-station systems. They offer smaller step size (<25 kHz, smaller than the reference frequency). A variety of models is available in the frequency range from 50 to 3200 MHz, in surface-mount packages and connectorized versions, to meet the varying needs of the industry.

What is Fractional-N Synthesis?

In a conventional PLL synthesizer, the divisor *N*, by which the output frequency is divided for comparison with the reference frequency, must be an integer. Such a PLL has a channel resolution equal to the reference (typically 25 to 1000 kHz). In a fractional-*N* synthesizer, the output frequency f_o is given by

$$f_o = (N + 1/M)f_r$$

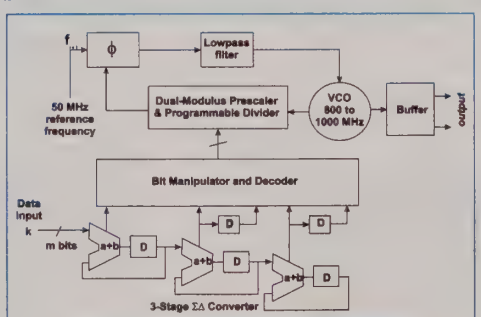


Fig. 1 — Fractional-*N* Synthesizer block diagram

where f_r is the reference frequency (typically 5 to 50 MHz) and *N* and *M* are integers. From this equation, we produce the effect of dividing f_o by a non-integer, allowing step sizes smaller than the reference. Fractionality is achieved by dividing the output frequency by *N* + 1 every *M* cycles and dividing by *N* the rest of the time. The synthesizer toggles between the above two frequencies, the average of which over a very small time interval (such as 1 ms) is the desired output frequency. This process creates discrete spurious outputs. A digital compensation circuit "averages" these disturbances into a clean, single-frequency output, cancelling unwanted output frequencies (referred to as *spurs*).

Synergy's fractional-*N* synthesizer is at least 10 times faster than a conventional synthesizer, with close-in (10 to 1000 Hz from the carrier) phase noise performance that is typically 20 to 40 dB better. The close-in phase noise depends on the output frequency and the reference. The fractional-*N* synthesizer also exhibits enhanced microphonic performance due to the wider loop bandwidths used. Wide-ranging loop bandwidths (typically 10 to 100 kHz) are possible and can be chosen by the user.

The basic building blocks of a high-quality fractional-*N* synthesizer are: a VCO with low phase noise, frequency dividers, a dual-modulus divider, a phase detector, a sigma-delta modulator, an active LPF, and a buffer amplifier (optional), besides a high-quality, external reference-frequency source. Fig. 1 shows the functional block diagram of Synergy's fractional-*N* synthesizer.

Improved Phase-Noise Performance

In general, different portions of a PLL synthesizer determine its close-in and far-from-carrier phase-noise performance as follows:

- *At offsets within the loop bandwidth*, the phase noise is determined by the loop components, such as dividers, the phase detector, other active components, and the external reference source. The resultant noise level at the phase detector is deteriorated at the output by 20 log(*N*).

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SPECIAL FEATURES

✓ Controllable via an RS-232 serial bus or with an optional 6-bit parallel bus for applications requiring microsecond switching speeds.

✓ Low spurious output is guaranteed by on-board, low-noise voltage regulators and high-quality decoupling networks, Intelligent choice of reference to avoid beat notes, and proper selection of sigma-delta converter noise breakpoint versus reference noise in addition to the fractional-*N* principle itself.

✓ We offer VCOs covering either a 1:2 tuning range with high resolution or, for extremely low phase noise applications, a 5% (typical) tuning range using a ceramic resonator.

✓ For very low phase noise applications, an internal high-voltage dc supply (28 V) allows the use of VCOs with low tuning sensitivity and improved phase noise performance.

✓ Can be driven with references from 5 to 50 MHz.

- *At offsets outside the loop bandwidth*, the phase noise is determined solely by the quality of the VCO.

In conventional PLLs operating at small step sizes, the division ratio is large because the step size must be equal to the reference frequency at the phase detector. As a result, significant phase-noise degradation occurs according to the 20 log(*N*) relationship. At the same time, because the loop bandwidth must be narrow enough to provide sufficient reference suppression, the frequency span over which the loop controls the system's phase-noise performance is restricted. Also, narrower loop bandwidths equate to slower switching speeds.

In a fractional-*N* synthesizer, the division ratio is much smaller, due to the fact that the comparison is done at a much higher frequency (typically 50 MHz) compared to the step size, thus minimizing the 20 log(*N*) phase-noise degradation at offsets within the loop bandwidth. Because the reference frequency at the phase detector can now be much higher for small step sizes, the loop bandwidth can be much greater, reducing switching time and widening the frequency span over which the loop controls the system's phase-noise performance. This results in the simultaneous achievement of low close-in phase noise and fast switching even with smaller step sizes (<25 kHz). To

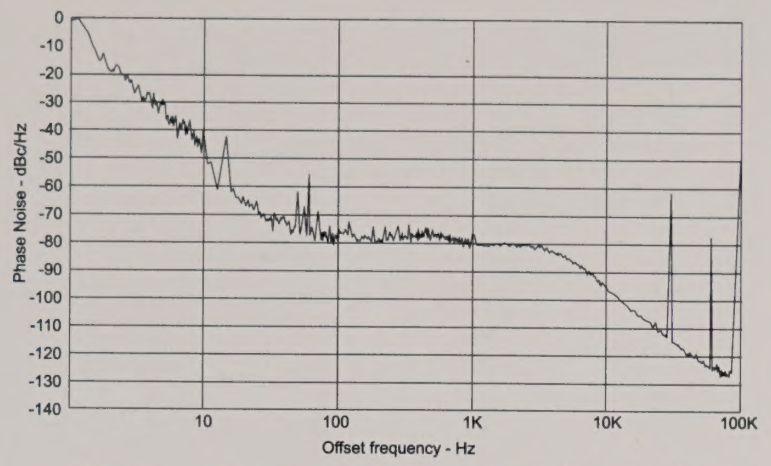

Fig. 2(a) — (b) phase noise of a conventional synthesizer

derive the full benefits of the fractional-*N* synthesizer utilizing a three-stage sigma-delta modulator, it is recommended to use a quiet high-frequency reference source to achieve excellent phase noise performance. Figures 2a and 2b show the phase-noise plots for fractional-*N* and conventional synthesizers, respectively.

Who Needs Fractional-*N* Synthesizers?

Synthesizers are found in most wireless applications: from battery-operated cellular and cordless telephones to wireless networks, base stations and commercial test equipment. Fractional-*N* synthesizers, based on advanced digital circuitry, offer much higher resolution compared to traditional synthesizers based on multiloop techniques.

Typical wireless applications require steps of:

• 5 kHz • 15 kHz • 25 kHz
• 30 kHz • 50 to 1000 kHz

or arbitrary sizes and offsets. The fractional-*N* technique can be enhanced to provide quasi-arbitrary resolutions of better than *1 millihertz* (mhz). It can replace complicated multiloop synthesizers in any type of receiver, signal generator, or synthesizer-based system.

With an upper frequency limit of about 3 to 3.2 GHz, Synergy's fractional-*N* synthesizers are well-suited for such critical applications as low-noise signal generators. They can compete with a large number of synthesizers on the market, and can also be used as a building block for OEM synthesizer designs.

For further information and detailed technical specifications, please contact our sales department.

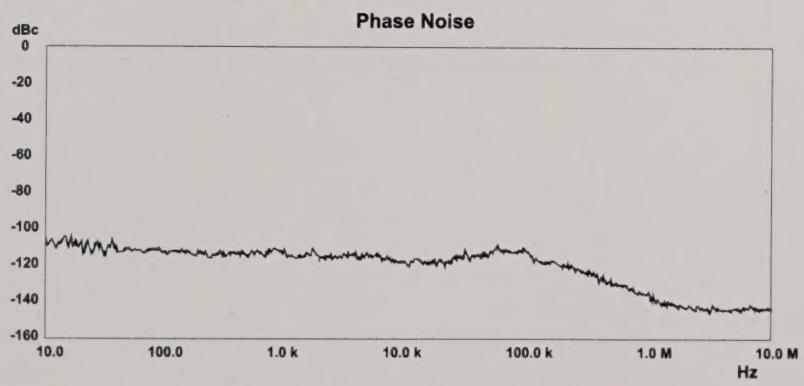

Fig. 2(b) — Phase noise plot of fractional-*N* synthesizer using

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2. PRICES AND TERMS

Price, terms and availability of merchandise are subject to change without notice, including and not limited to changes caused by fluctuations in market price, availability or changes beyond Seller's reasonable control. All invoices are due and payable 30 days from the date of invoice. If in Seller's judgement, the Buyer's financial condition does not justify the terms of payment herein specified, Seller may require full or partial payment in advance of either production or shipment. If such payment is not made, Seller may cancel any part of the outstanding order.

3. TAXES

The prices applicable to this order do not include any allowance for federal, state, local or any other sales tax which may apply to the transactions contemplated by this order. The amounts of such taxes shall be payed by the Buyer.

4. SHIPMENTS

Shipment dates are based upon Seller's best judgements and are subject to factory schedules and production limitations. Every possible effort will be made to assure that the scheduled delivery dates are met. Accordingly, Seller can assume no liability, consequential or otherwise, of any sort or nature, resulting from any delay caused by act of God, fire or other casualty, accident, strike, shortage of labor or materials, governmental action or other cause beyond Seller's control. The time for Seller's performance shall be extended by the period of any such delay. Seller reserves the right to apportion its production among its customers as it may determine. Shipments will be made via requested shipment mode. When shipment mode is not specified by the buyer, shipments will be made via U.P.S. prepaid and bill. The F.O.B. is Paterson, N.J.

5. WARRANTY

SYNERGY MICROWAVE CORPORATION warrants that the components to be delivered shall, at the time of delivery, be free from defects in material and workmanship. Synergy's obligation under this warranty is limited to the repair or replacement of the defective parts; all freight costs to and from Synergy's plant will be paid by the buyer. This warranty shall remain in effect for the period of one year from the date of shipment. Synergy shall have no liability for special, incidental or consequential damages resulting from improper use, negligence or accident, complete or partial disassembly of the components will void this warranty.

A fee to cover the analysis costs on the returned components under this warranty will be charged to the buyer if, when after examination by Synergy, the components are found to meet the specifications or have failed for reasons not covered by this warranty. No returns will be accepted by Synergy if the proper Return Authorization Number is not attained from Synergy prior to returning the damaged devices.

The warranty stated herein is exclusive and in lieu of other warranties expressed or implied.

6. PRODUCT SPECIFICATIONS

Specification changes are subject to acceptance by Synergy, including price revisions and any adjustments necessary to cover material procured, processed and labor expended prior to receipt by Synergy of revised specifications. Published specifications are subject to change without notice and may be verified for correctness by contacting Synergy Microwave Corporation directly.

7. INSPECTION

Buyer shall have the right and shall be given the opportunity to inspect the goods at Synergy's facility and prior to shipping, for a nominal fee and shall be so conducted as not to interfere with Synergy's normal operations. Such inspection, must be stated in the Buyer's acknowledgement and shall have been previously quoted in writing by Synergy.

8. FAIR LABOR STANDARDS ACT

Synergy certifies that all items shall be manufactured or furnished in accordance with the applicable requirements of the Fair Labor Standards Act of 1938, as ammended.

9. SELLER'S LIABILITY

Buyer shall not in any event be entitled to, and Synergy shall not be liable for indirect, special, incidental or consequential damages of any nature, including and not limited to loss of profit, promotional or manufacturing expenses, overhead, injury to reputation or loss of customers. Buyer's recovery from Seller, for any claim shall not exceed Buyer's purchase price for the products, irrespective of the nature of the claim, whether in contract, tort, warranty or otherwise.

10. ATTORNEY'S FEES

If any litigations are brought to inforce any rights created hereby, the prevailing party shall be entitled to attorney's fees and cost.

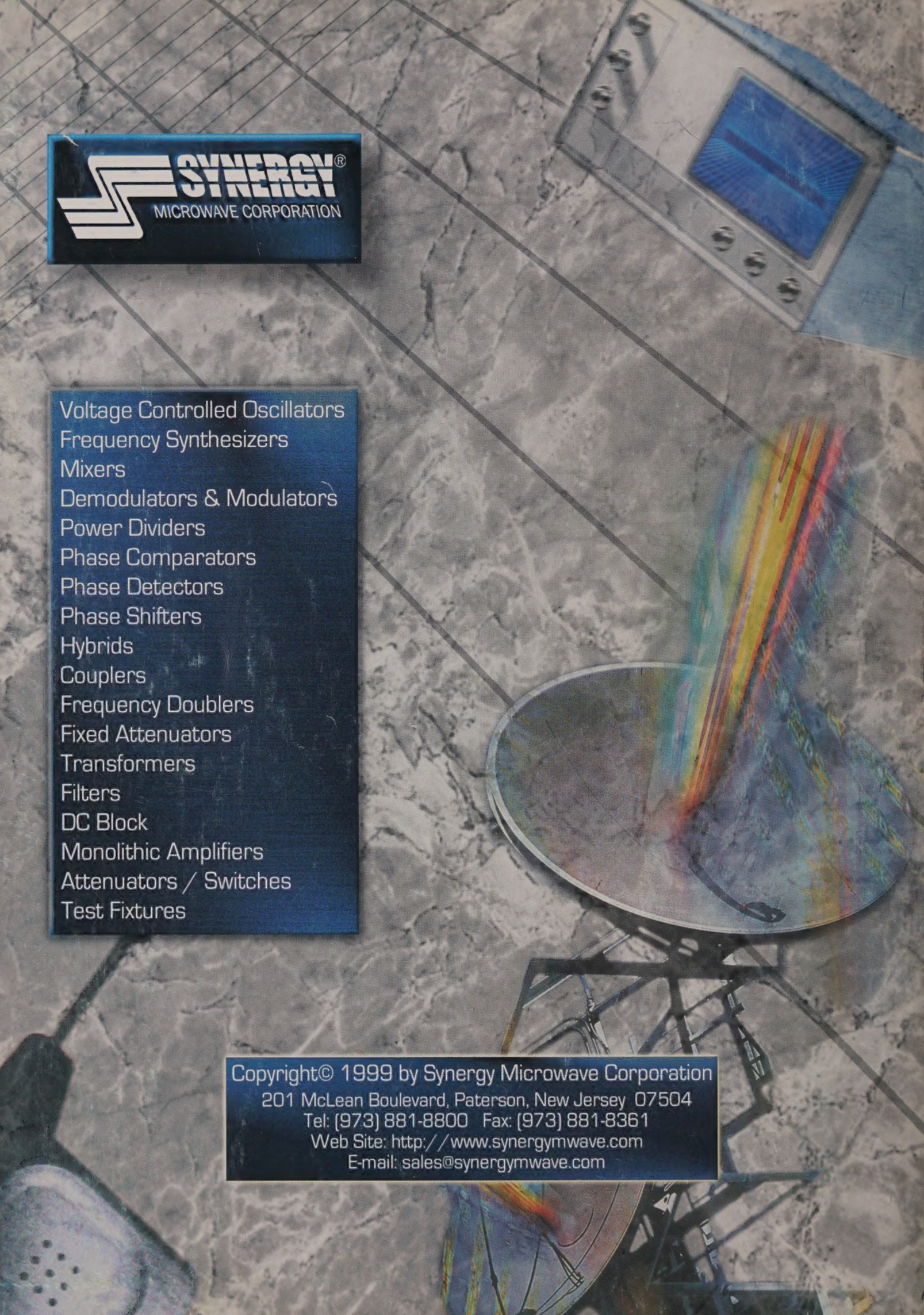
11. GOVERNING LAW

All rights and obligations shall be governed by the law of the state of New Jersey, United States of America.

12. CANCELLATION

Buyer may cancel orders by written notification, provided that the agreed upon price of all products which are completed, manufactured, and allocable to this order, at the time of receipt of such notice of cancellation is payed to Synergy. The Buyer will also pay Synergy for all costs direct or indirect, which have been incurred by Synergy for products that have not been completely manufactured at the time of receipt of cancellation. Wherever possible and to minimize such costs, Synergy will attempt to divert completed parts or work-in-process from cancelled orders to complete other orders. Orders for custom parts are non-cancellable, unless agreed to by Synergy.

SYNERGY'S FEDERAL SUPPLY CODE NUMBER IS 63155



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